AD

AVSCOM REPORT NO. 76-43

Production Engineering Measures Program
Manufacturing Methods and Technology

MANUFACTURING METHODS REPORT
FEASIBILITY OF PRE-PROGRAMMING FOR ATLS

Robert N. Little and Charles A. Wells
IIT Research Institute
Management and Computer Sciences Division
10 West 35th Street
Chicago, Illinois 60616

September 1976

Final Report   Contract Number DAAJ01-76-C-0040

Approved for public release: distribution unlimited

Prepared for

US ARMY AVIATION SYSTEMS COMMAND
St. Louis, Missouri 63166

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Mention of any trade names or manufacturers in this report shall not be construed as advertising nor as an official endorsement or approval of such products or companies by the United States Government.

DISPOSITION INSTRUCTIONS

Destroy this report when it is no longer needed. Do not return to the originator.

ii

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AVSCOM Report No. 76-43	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Manufacturing Methods Report. Feasibility of Pre-Programming for ATLS.		5. TYPE OF REPORT & PERIOD COVERED Final rept.
		6. PERFORMING ORG. REPORT NUMBER H6048
7. AUTHOR(s) Robert N. Little Charles A. Wells		8. CONTRACT OR GRANT NUMBER(s) DAAJ01-76-C-0040
9. PERFORMING ORGANIZATION NAME AND ADDRESS IIT Research Institute Management & Computer Sciences Division 10 W. 35th St., Chicago, IL 60616		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PEM Project: 1758162
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Aviation Systems Command P.O. Box 209 - ATTN: DRSAV-EXT St. Louis, MO 63166		12. REPORT DATE September 1976
		13. NUMBER OF PAGES 286
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) IITRI-H6048		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) USAAVSCOM 289p.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) 76-43		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) ATLS, ATLAS, Automatic Tape Layup System, Composite Tape, Fiberglass Tape, Helicopter Rotor Blade Manufacture, Part Description Language, Tape Layup System.		

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Preprogramming NC control tapes for ATLS (Automated Tape Layup System) using computerized methods is demonstrated to be feasible. An interactive ATLS Software System is constructed and utilized to create control information on tape which is subsequently employed to demonstrate the manufacture of fiberglass components for the CH-47FRB helicopter rotor blades. The economics of digitizing compared to preprogramming with the ATLS Software System Language are estimated, and recommendations are made for extensions to control other ⟶ next page

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

iii

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

410 125

cont

tape layup systems and manufacture components of different geometrical configuration.

FOREWORD
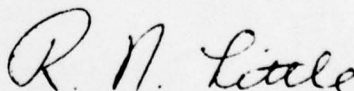
This report presents the results of a study project to demonstrate the feasibility of achieving a pre-programming capability for an automated tape lay-up system (ATLS) developed separately by the Army. The findings represent the first step in achieving the long range objective to fully develop the necessary technology for the automated preparation of program manuscripts of helicopter rotor blades from engineering data, for subsequent manufacture on the ATLS.

The study was sponsored by the U.S. Army Aviation Systems Command, Product Engineering Division, under contract DAAJ01-76-C-0040. Mr. Dan Haugan and Ms. Bernestine Page served as Project Monitors.

This project was accomplished as part of the U.S. Army Aviations Systems Command Manufacturing Technology program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques, and equipment for use in production of Army materiel. Comments are solicited on the potential utilization of the information contained herein as applied to present and/or future production programs. Such comments should be sent to: U.S. Army Aviation Systems Command, ATTN: DRSAV-EXT, P.O. Box 209, St. Louis, Missouri 63166.
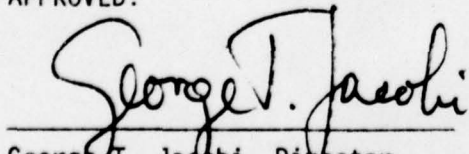
The ten month effort covered by this report began in November 1975 and was concluded in September 1976. The work was performed by G. P. Putnam, C. A. Wells, and R. N. Little from IIT Research Institute (IITRI) with the cooperation of M. J. Rohner and E. Frank of the Boeing-Vertol Company.

Respectfully submitted,

R. N. Little
Senior Engineer

APPROVED:

George T. Jacobi, Director
Management and Computer Sciences Division

v

TABLE OF CONTENTS

1. INTRODUCTION

The development of the concept of building helicopter rotor blades from advanced composites resulted in the need for automating laborious hand methods for constructing blade components. Toward this end, the U.S. Army Aviation Systems Command funded a project with Goldsworthy Engineering, Inc. (Contract DAAJ01-72-C-0610 (PIG)) to build a suitable machine for laying fiberglass epoxy tape in various widths and fiber orientations. The completed machine, called an Automated Tape Layup System (ATLS), was installed at the Boeing-Vertol facility in Philadelphia, PA.

The machine is numerically controlled, and it was expected that the NC tape control information would be created through a digitizing process built into the control system furnished by Allen Bradley. However, it was soon apparent that this process would also be extremely laborious, and wasteful of machine time. Therefore, it became appropriate to inquire into alternative methods for creating the control information through preprogramming.

Boeing began to use hand methods to pre-program the control information, but this was also time consuming and susceptible to human error due to the manual handling and generating of large quantities of data.

Computer assisted pre-programming has been used successfully in many other applications of numerical control so it was natural to consider this method in this instance. Consequently the project reported herein was established to investigate the feasibility of pre-programming the ATLS using computerized methods.

The following sections describe this investigation and the results obtained, including technical and economic factors. Conclusions drawn from the investigation and recommendations for further work complete the report. Detailed technical information is relegated to appendices.

1

2. SYSTEM ASSESSMENT

At the outset of the project, an inspection of the ATLS was conducted at the Boeing-Vertol facility in Philadelphia. IITRI, Boeing staff and the AVSCOM project monitor were present. The design and manufacturing steps to produce a fiberglass helicopter blade were reviewed. These are, briefly:

a. Produce airfoil design.
b. Produce structure design.
c. Produce detailed component design.
d. Produce tooling design.
e. Produce NC tapes for ATLS components.
f. Build tooling and individual components.
g. Preform components.
h. Assemble components in mold.
i. Cure assembly in mold.
j. Finish assembly.

Numerous inspection and quality control procedures are used throughout to insure quality results.

The focus of this investigation was on step e, the production of NC tapes for ATLS components. To demonstrate feasibility, it was deemed adequate to produce NC tapes for a component known as a "root loop" in the CH-47C spar subassembly. Prior to preforming (step g), the root loop looks like a 30 ft. long hairpin whose thickness tapers to just a few plies of tape at the open end. The heavy thick loop end supports the full centrifugal force of the rotating blade and therefore consists of many (144 for the CH-47C) layers of fiberglass.

The original concept of the investigation was to compare digitizing to computerized pre-programming as an alternative NC tape preparation method. However, Boeing could not supply digitized data due to not being able to use the digitizer. They had, however, used manual methods to prepare test versions of "root loop" NC tapes, and this information was substituted as the baseline for study comparisons. Copies of a set of hand programmed NC tapes were given to IITRI for further detailed analysis regarding format, function codes, and process sequences for the part under consideration.

2

The three functional areas included in this phase of the project were: 1) Engineering design functions, 2) Special tooling, 3) The features of the "ATLS" and how they are currently being used in the manufacturing process.

2.1 Engineering Design for Fiberglass Helicopter Blades

The aerodynamic design of the helicopter blade is supplied to the engineering group at Boeing that is responsible for the final design layout. This design is in the form of a drawing representing the outside dimensions at various cross sections throughout the length of the blade. At this point, the root section of the blade is not included in the design.

The design process continues with the development of cross sectional areas and blade wall thicknesses based on considerations of the rotational forces to be encountered and the number of longitudinal fibers of glass required to give the desired strength. These considerations along with mechanical mounting considerations are used to extend the design to the root section and strap assemblies of the blades. At this point, the blade is composed of several separate longitudinal component parts which will be manufactured separately and later joined into a single component.

The output of this design process is a drawing depicting the detailed cross sections including both inside and outside dimensions as well as the boundaries of the various individual longitudinal component parts. Also included on this drawing is a detailed layout of the fiberglass tape plies for the individual components. This includes the number of plies at each cross section which therefore specifies the longitudinal taper of component parts.

2.2 Special Tooling and Blade Manufacture

Certain of the component parts of the final blade are layed up on special mandrels created for this purpose. The design of these mandrels follows directly from the design of the specific blade component. The remainder of the blade is layed up on a specially fabricated "rubber balloon" that generally conforms to the shape of the desired inside dimensions of the blade when inflated.

3

This and the remaining component parts are assembled in a mold that has been machined to conform to the outside dimensions specified in the original aerodynamic design. The mold is then closed, the balloon core is inflated to force the fiberglass against the mold, and the mold is electrically heated to facilitate curing of the epoxy. After curing, the balloon core is deflated and extracted through the open end of the blade. The blade is then removed from the mold and ready for the addition of final components such as the hard nickel leading edge.

2.3 The Automated Layup System (ATLS)

Detailed operation data was collected on the ATLS. During the trip to Boeing Vertol, the IITRI project staff had the opportunity to observe the ATLS during test maneuvers. The current use was also discussed with the group at Boeing. It was learned that Boeing is currently not using the digitizing function of the Allen Bradley 7300 controller. Control tapes are produced by "hand coding" the various controller command codes directly. Boeing Computer Services has provided them with the software to punch the control tape. At present, this software system performs only rudimentary end-of-card formatting and character code conversion before punching the control tape.

The automated layup proceeds as follows: first, certain of the component parts are selected as candidates to be produced on the ATLS. Initially, this was limited to the root end strap component. A mandrel is developed based on the drawing developed in the design effort. This appears to be a relatively straightforward application of the inside dimensions that were developed for the various cross sections. The mandrel is then assumed to be mounted on the ATLS with a specific orientation and the "hand coding" of machine functions proceeds. This coding is done on specially prepared manuscript forms which are reproduced with certain fixed information already filled in. It is from these forms that the machine codes are punched into cards for input to the translation software that produces the control tape. The control tape can then be tested on the ATLS and any corrections can be made by iterating the above process.

At the current early stages of use, a number of the features of the ATLS are not being used in the programming of the "root loop" strap component.

4

a. Blade component selection is limited to simple components that can be represented and programmed in two dimensions. This limitation is caused by the extreme complexity of the manual programming task at the machine control code level.

b. The mounting of the mandrel on the ATLS is limited to those orientations that do not introduce any extra axis of motion into the program. Again, this is the result of the complexity of handling three simultaneous axes of motion.

c. Boeing has found through trial runs that the best of the available tape applicator designs is the solid spatula-like applicator. The various roller and rubber tire applicators have not proved as useful.

d. Tape slitting and tape cutter rotation are not used due to the simple shapes of the chosen components.

The specific tangible items collected during this assessment phase are listed below.

1. Two volume final report on ATLS by Goldsworthy Engineering.

2. ATLS Operation and Maintenance Manual.

3. Technical Specifications for the purchase of the Allen Bradley 7300 control subsystem by Goldsworthy Engineering.

4. Copy of the control codes from the original Allen Bradley documentation at Boeing Vertol and annotated by the Boeing personnel involved in programming (Ed Frank).

5. A drawing of the spar layup for the CH-47C.

6. Computer listing of the existing control tape for the strap assembly for the CH-47 spar.

7. Copy of the existing control tape for the CH-47C spar strap assembly.

3. SYSTEM ANALYSIS

This phase of the project concentrated on establishing the requirements for language development, the interfacing requirements to the ATLS control system, the ATLS functions available for automatic control, and the proper representation of design data for input to the ATLS software system. This was accomplished through intensive study and analysis of the material obtained during system assessment. A key activity of the analysis was the preparation of perspective plots of the NC data from the Boeing furnished EIA coded NC control tapes. The plots give a quick visual overview or detailed views of tape applicator motion due to X, Y, and Z axis changes. The plots were augmented by the generation of postprocessor style listing derived from the same tapes. Special computer software was prepared to automate the production of plots and listings.

The following determinations were made during the course of analysis:

3.1 Language Requirements

The language should be simple, but sufficiently high level so as to substantially reduce human labor with respect to the hand coding technique developed by Boeing. Toward this end, it was desirable to describe the geometric parameters of the part being fabricated, and the madrel, rather than how the machine should move in order to fabricate the part. A language that commands machine motion would be too close to manual programming to result in an economic or process time advantage for a large number of similar parts.

3.2 ATLS Interface Requirements and the AB7300 Control

ATLS interface requirements and automatic functions controlled by the Allen Bradley 7300 system were spelled out in detail in the Goldsworthy manuals. The subset required for "root loops" was determined by inspection of the listings of the hand coded NC tapes. NC tape codes in either ASCII or EIA standards are acceptable input.

The interface and control requirement thus boiled down to providing EIA or ASCII coded data in word address format in the proper process sequences. These sequences were essentially established by the manual programming methods used by Boeing for the two types of layup necessitated by the root loop

7

geometry and the machine geometry restrictions of the ATLS. Our judgement was that the Boeing process sequences and tooling were appropriate for the purposes of the feasibility investigation, and that their usage would simplify comparisons.

3.3 Design Data Analysys for Input Requirements

Two types of information were available for describing the "root loop". The primary data gave cross section areas at various stations along the blade. The secondary data, which had been derived from the primary data, gave the number of plies (with prescribed tape width and thickness) at the same blade stations. It was implied that linear algebraic functions described the ply taper. It was determined that, for simplicity, the geometric profile of the ply pack should be described in terms of the number of plies at each significant station for this stage of process automation. Future automation development might well push into the area of component geometry detailing and thus gain further economic benefit.

4. SOFTWARE DESIGN

A software system was designed to automate the production of ATLS NC control tapes subject to the limitations and requirements described in the previous sections.

4.1 Implementation Language Selection

As part of the design activity, a brief investigation was conducted on the desirability of using APT (an established and standard numerical control language) or FORTRAN (a standard computer system language) as the implementation language.

After some consideration and experimentation we decided to use FORTRAN for the following reasons:

a) APT, although rich in geometry, has very limited logical capability. FORTRAN is far superior in this regard and the "root loop" problem required more logic than geometry. Therefore, programming in APT for this problem would be more complex and costly than programming in FORTRAN.

b) Using APT would have required building or modifying an APT postprocessor. This, and the use of APT, was considered undesirable from a project time and cost viewpoint. Postprocessing for this control system amounts to formatting the output data in word address EIA or ASCII code, which is easily handled with FORTRAN.

c) Tape shearing must occur a fixed distance (approximately 13.5 inches) prior to the end of a tape layer. This function could be handled in a postprocessor but would be difficult in APT Section I style computing. It is relatively easy to handle with a specially designed FORTRAN program.

9

d) FORTRAN implementation makes the results usable on a large
    variety of computers, including mini-computers, without re-
    quirements for other more expensive language systems.

e) Processing costs for use of the resulting systems are in
    general minimized using FORTRAN as opposed to APT.

f) The use of either language would satisfy the objectives of
    the investigation.

4.2 System Description

A computer software system was designed to support the primary objective
of the project, i.e., to show feasibility of pre-programming the ATLS using
computerized methods. The design, which has satisfied that objective and
which meets the specification requirements given in Section 3, is detailed be-
low according to three distinctly separate major functions:

●   Analysis - Modules to aid in the analysis of existing and
    subsequently generated ATLS control tapes.

●   Synthesis - A module that will generate an ATLS control
    tape for a specified test component. The descriptive language
    parameters for this component are entered as variable data.

●   System Support - Utility routines that support the operation
    of the analysis and synthesis functions.

The bulk of the program modules that comprise this system were written
in FORTRAN IV for a Digital Equipment Corporation PDP-11/45. Two subroutines,
however, had to be written in assembly language to accommodate reading and
punching of EIA codes on paper tape.

As shown in Figure 1, the three functions of this system are provided by
five main programs:

10

SYNTHESIS

ANALYSIS

Description Card Input

PLYGEN

Listing

Data Storage

ATLSGR

Graphic CRT

Keyboard

ATLSLI

Control Tape Listing

PTLOAD

PTDUMP

Paper Tape

Paper Tape

SUPPORT

Fig. I   ATLS PROGRAMMING SYSTEM

11
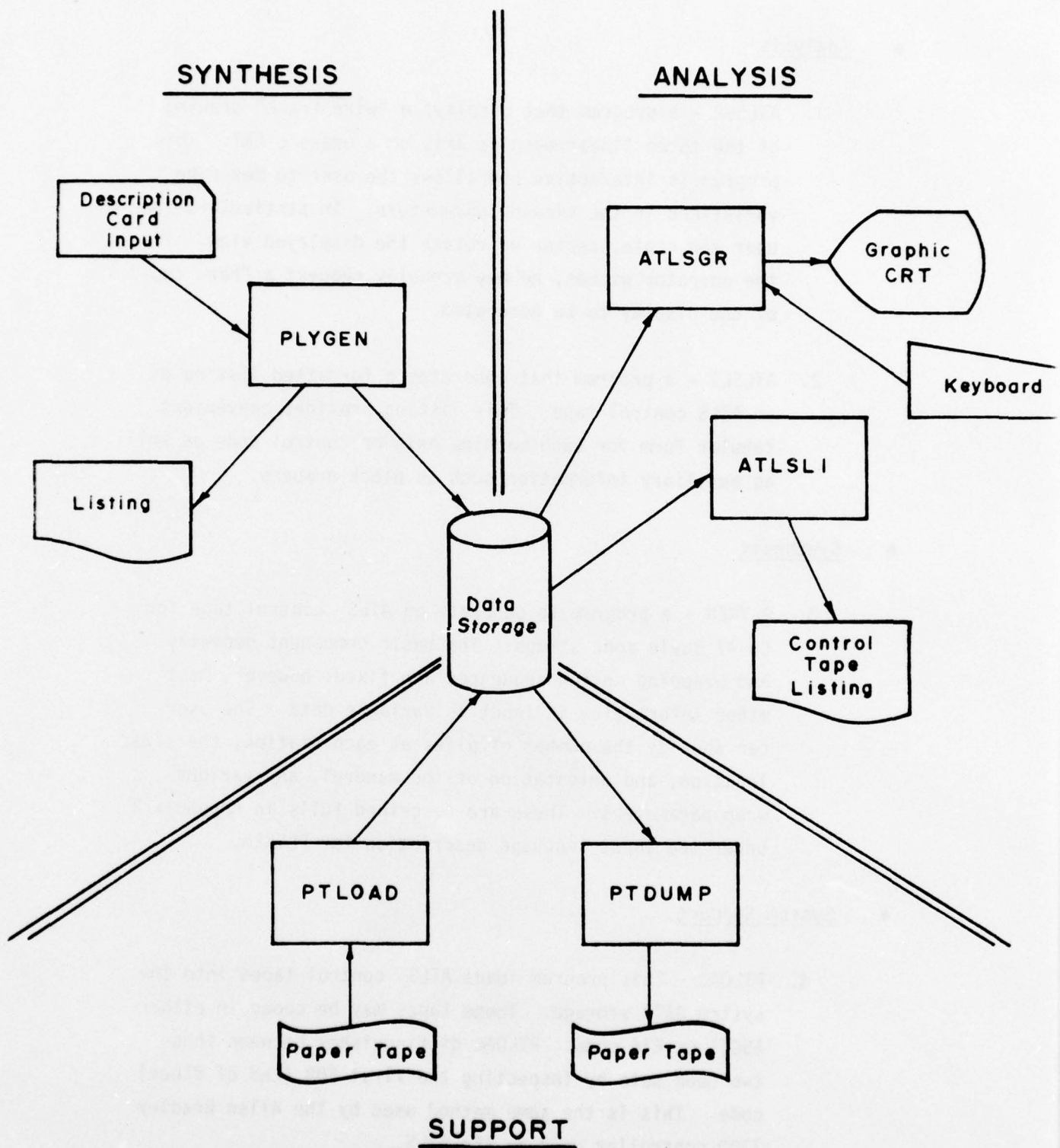
- **Analysis**

    1. ATLSGR - a program that displays a "wire frame" drawing of the three linear machine axis on a graphic CRT. This program is interactive and allows the user to describe variations in the viewing parameters. In particular, the user can scale, center or rotate the displayed view. If the operator wishes, he may manually request a "hard copy" of the display to be generated.

    2. ATLSLI - a program that generates a formatted listing of an ATLS control tape. This listing provides convenient tabular form for each machine axis or control code as well as auxiliary information such as block numbers.

- **Synthesis**

    3. PLYGEN - a program to generate an ATLS control tape for CH-47 style root straps. The basic component geometry and wrapping motion sequences are fixed; however, most other information is input as variable data. The user can specify the number of plies at each station, the size, location, and orientation of the mandrel, and various wrap parameters. These are described fully in Appendix B under the input language description for PLYGEN.

- **System Support**

    4. PTLOAD - This program loads ATLS control tapes into the system DATA storage. These tapes may be coded in either ASCII or EIA code. PTLOAD distinguishes between these two code sets by inspecting the first EOB (End of Block) code. This is the same method used by the Allen Bradley 7300 controller used on the ATLS.

5. PTDUMP - this program punches a control tape stored in the
    system data storage to paper tape. The current date and
    time along with other optional text information is punched
    in man-readable leader by this program.

The five main program modules all interact with a central data storage
facility (file system) provided by the computer operating systems. This
approach was chosen for its operational ease. Paper tapes can, however, be
entered into or retrieved from the central data storage facility by using the
support programs.

4.3 System Application

The system is designed for use in two basic situations which are described
below:

- Analysis of an Existing Control Tape. An existing control tape
  can be entered into the data storage via the program PTLOAD.
  This program will accept control tapes punched in either ASCII
  or EIA codes. Once stored in the system, the control tape can
  be used to generate a formatted tabular listing or graphical
  output.

- Generation and Analysis of a New Control Tape. When the proper
  input parameters are entered into the program PLYGEN, it gener-
  ates the control tapes for the CH-47 root strap style wrap. Two
  different control tapes are generated corresponding to the two
  wrap styles currently being used at Boeing Vertol. The program
  stores both of these control tapes in the system data storage
  for future analysis. Either of these control tapes can then be
  analyzed with the aid of ATLSLI or ATLSGR. If errors are detected,
  the operator can modify the original input parameters to PLYGEN
  and iterate through this entire process once again. If no errors
  are apparent from the analysis, the tape can be punched using
  PTDUMP.

13

5. TEST RESULTS

Original planning for this project called for testing of the ATLS software by comparison of a proven digitized NC tape with one generated by the new software. This could not be done since no digitized tapes were available. However, a comparison was made with the hand programmed tapes prepared by Boeing. Listings and CRT plots of the tapes were created using the modules ATLSLI and ATLSGR, and the results were determined to be functionally equivalent and within engineering tolerance.

Near the end of the project Boeing expressed a desire to help test the newly prepared tapes on the ATLS. These tests were conducted on August 25 and 26, 1976. In attendance were B. Page from AVSCOM, E. Frank from Boeing Vertol, and R. Little and C. Wells from IITRI. The NC tapes tested were for CH-47FRB Spar Strap ("root loop") described on Boeing Vertol Print No. 114R1710.

Two tapes were provided in accordance with Boeing procedures and tooling. The first tape was for plies 1 through 50 in the so-called "propeller wrap" configuration in which the principal linear motion for ply application is parallel to machine Y axis. The Y axis or transverse axis coincides with the shorter horizontal dimension of the ATLS bed.

The second tape, a "flip wrap" configuration for plies 51 through 155, has principal linear motions of up to twenty-eight (28) feet that are parallel to the machine X axis. The X axis or longitudinal axis is parallel to the ATLS bed and perpendicular to the Y axis.

Two problems were encountered in testing that precluded the manufacture of a complete 144 ply "root loop". However, the first 50 ply portion of the "root loop" was successfully made and the machine was run in air (no mandrel was used) for the remaining plies. It was the judgement of those in attendance that the motions of the machine were correct during the air trial.

The problems encountered were as follows. First, the mandrel rotation direction for the A axis, a rotary axis parallel to the X axis, was incorrect in some instances due to misinterpretation of sign ($\pm$) conventions for the axis commands.

14

Second, the plexiglass layup mandrel retaining plates were designed to be one sixteenth of an inch higher than the completed laminate. A fine scribe line was put on the plexiglass to define the completed laminate outline to serve as a visual inspection aid. This additional height did not permit the ATLS compaction foot to reach the layup surface.

For the purposes of the tests these problems were overcome in the following manner. IITRI modified the NC tape by editing on a teletype to produce a correct version. Boeing removed the plexiglass layup mandrel retaining plates during the tests.

Subsequent action was taken by IITRI to correct the ATLS software interpretation of rotational directions and to incorporate recommended changes in approach and liftoff patterns for improved tape placement. Boeing removed a tenth inch of material from compaction foot offsets to permit proper engagement between the foot and mandrel.

The tests successfully demonstrated that it is feasible to pre-program the ATLS using computerized methods. Photographs taken during testing may be found in Appendix A.

6. TECHNICAL ANALYSIS

The detailed experience gained on this project was directed at a specific component part of a fiberglass helicopter blade, manufactured in a particular style developed by Boeing Vertol and on a particular machine system called ATLS. However, we believe this experience is extendable to similar situations, and therefore offer our advice on several pertinent aspects.

6.1 Programming for a Variety of Composite Structures

The techniques used for the "root loop" are quite applicable to any composite structure formed by a numerically controlled machine using pre-impregnated tape. Basically, we identified the critical parameters of the manufacturing sequence, determined a simple but complete way to describe the part to be fabricated and its special tooling, determined the appropriate machine (ATLS) functions to control, and wrote a computer program to transform the part description (input language) into the appropriate sequence of control functions (NC tape output). We did not try to describe all parts, but only a reasonably large class of similar parts. We observe that the computer program might be written in FORTRAN or in APT, primarily depending on the nature of the geometrical versus logical problem presented and the availability of suitable computer service. Programs of this type written in APT would probably make heavy use of complex macros, and a special post-processor would be required to insert delayed result functions such as tape shearing at prior positions in the CL file sequence. The CL (cutter location) file produced by APT is a list of individual machine axis motions interspersed with feedrates and auxiliary function commands (e.g., tape shearing). A post processor modifies a CL file to suit a particular NC machine. An APT system that allows the use of current CL data in the definition of geometry would also be desirable.

Other geometrical shapes that could be treated are:

A. Flat tapered spar packs (similar to "root loop" without the "loop").

16

B. Single thickness flat layups consisting of flat irregular
    regions with side by side tape strips in a specific
    orientation.

C. Multiple thickness flat layups composed of superimposed
    single layer types described in B.

D. Cylindrical surface layups with both single and multiple
    thickness.

E. Multiply curved surfaces described as sculptured surfaces
    or with MDI data.

The currently used flat spatula foot on the ATLS could not be used in
situations D and E due to machine and surface geometry.

6.2 Use of Higher Level Engineering Data

The Engineering Data used for the "root loop" consisted of a simple
geometrical description of the component part in terms of tape width, tape
thickness, and the number of tape plies on a specific mandrel at various
stations along the length of the mandrel. We feel this is an appropriate
level of data for input to the NC control tape preparation function. It
is sufficiently close to the physical action that will take place at the
ATLS so as to provide a basis for the checkout of programs and for quality
control during production.

This is not to say, however, that prior steps in the design process
(see Section 2 - System Assessment) would not benefit from additional com-
puterized aids. We feel that each of these steps may be substantially
automated, but that such automation is primarily an economic consideration
that is separate from ATLS control tape preparation.

An obvious and simple extension of ATLS software is the automatic
generation of ply data (inputs to PLYGEN) from the cross section cured area
data given in the material quantity chart (Boeing Vertol drawing #114R1710).
A further extension is the computerized breakdown of the blade spar into

17

individual components with specific cross sections so as to generate the cured area information.

6.3 Common Language for Multiple Machines

The design of the input language for ATLS software assured that the language itself would be quite independent of ATLS. This is true because the language basically describes a member of a class ("root loop" class) of parts to be manufactured. The language can be extended to describe additional classes and tooling, such as described in Section 6.1, but it is in no way dependent on the ATLS.

18

7.   ECONOMIC ANALYSIS

The economic analysis called for in the statement of work was intended to establish the economics of programming the ATLS as compared to digitizing. The digitizer has not been used by Boeing due to a machine manfunction which could create a personnel safety hazard and risk of substantial damage to the machine if an emergency stop condition is created. Therefore, since actual data is unavailable from digitizing, we are providing what we consider to be realistic estimates of time required for digitizing based on our examination of the machine, tooling, controls, and the part ("root loop") selected for comparison.

The digitizing job is a two-man operation since part of the work must be accomplished with the engineer/operator near the digitizing head while the remainder is a data entry operation for miscellaneous function codes and certain motions at the machine control cabinet. One man could do the job by walking back and forth between the two locations, but with probably a greater total expenditure of man-hours.

Let T_f = time/foot of fiberglass tape = 8 seconds

T_p = time/ply = 15 minutes

L = length of tape in feet = 955

N = number of plies = 144

M = number of men = 2

T = total time required for digitizing

Then T $= (T_f \cdot L + T_p \cdot N) \cdot M$

$= (8/60 \cdot 955 + 15 \cdot 144) \cdot 2$

= 4575 minutes

$\cong$ 76 hours

This assumes no errors are made. If there is a rework factor of 20%, then the test component would require about 91 man-hours.

As another baseline, Boeing has provided a preliminary estimate of 100 hours of programming effort for a similar CH-46 component to be fabricated on the PIN WRAP machine, a more specialized machine derived from ATLS. There is considerable uncertainty in both estimates since neither procedure has actually been accomplished.

On the other hand, the ATLS software method requires only a few language statements to describe the component and tooling. The total time to prepare the control tapes, including graphical checkout and listing examination approximates 6 hours. Assuming a labor rate of $9.50 per hour with a 65% overhead, the cost differential between digitizing and ATLS software methods is (91 hours - 6 hours) x $\frac{\$9.50}{hour}$ x 1.65 = $1332/tape.

Additional savings may be realized by avoiding setup and teardown of tooling for tape preparation through digitizing and by keeping the ATLS more available for production work. The latter is estimated at $50.00/ machine hour for 45 hours/tape or $2,250/tape. Further, the cycle time for developing a control tape with ATLS software is considerably shorter than digitizing, a circumstance which could lead to substantial economic benefit in a tightly scheduled program.

These factors are summarized in Figure 2 on the basis of savings per tape. Detailed information on procurement schedules for different but similar types of blades can be translated into total savings resulting from the use of pre-programming under the given assumptions.

```
Quantifiable Cost Savings

    1.  Reduction in Labor               $1,332
    2.  Recovery of lost machine           2,250
        production time


Additional Cost Benefits

    1.  Improved cycle time                  —
    2.  Reduction in number of setups        —


                        TOTAL            $3,582
```

Figure 2 . Summary of Cost Savings and Benefits
Per Pre-programmed NC Tape.

8. CONCLUSIONS AND RECOMMENDATIONS

The primary conclusion of the study was the highly successful proof and demonstration through live machine tests of the feasibility of pre-programming the ATLS using computerized methods. Secondarily, additional very promising areas for the automation of NC control tape production were identified: 1) both simpler and more complex shapes than the "root loop", 2) interfaces with higher level engineering data, and 3) the extension of ATLS software to the control of other composite tape layup machines using the same common language for input.

We therefore urgently recommend that in the next phase of development the following areas be further automated by extension to the ATLS part description language and ATLS software system:

A. Flat tapered spar packs.

B. Single thickness flat layups in irregular regions.

C. Multiple thickness flat layups in superimposed irregular regions.

D. Control of the PIN WRAP machine for spar packs.

We believe there is sufficient variety of component requirements in these categories to justify the software development costs.

Two additional areas for further development are:

E. Layups on cylindrical surfaces.

F. Layups on multiply curved surfaces.

These are technically more ambitious but may lead to improved structural design for blades by allowing manufacture of the entire helicopter rotor blade or blade spar on a single mandrel without using the current multi-component spar approach. Software design investigation for these problems requires concurrent exploration of improved tooling and fiberglass tape applicators. It would be especially useful if some additional degrees of freedom were available in the applicator head and if some form of extrusion could be used on the tape to continuously reshape its cross section while maintaining the same sectional area.

In addition to improving blade manufacture, these advances will enable the manufacture of more severely multiply curved panels that are not amenable to flat layup approaches using either tape or broad goods.

APPENDIX A

PHOTOGRAPHS OF TEST DEMONSTRATION

TABLE OF CONTENTS
for Appendix B

1. Initial Set Up for "Propeller Wrap" Showing Short Segments of Mandrel.
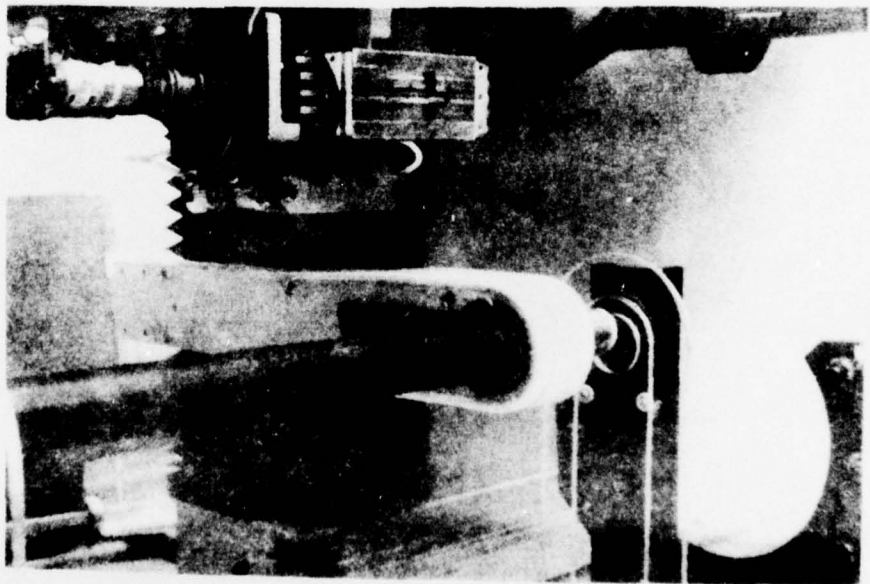
2. Starting a Ply.
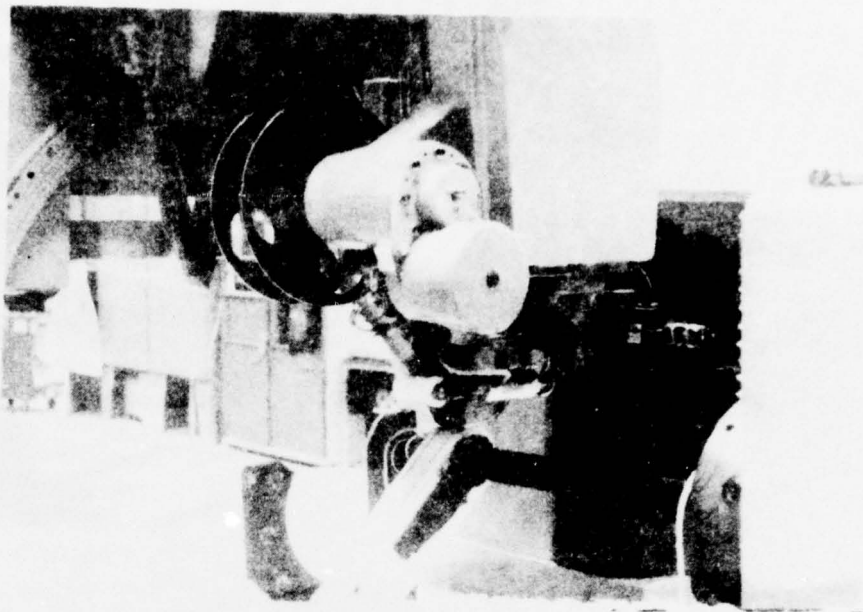
3. Mandrel D-Axis Rotation Around Pin End.

4. Completing a Ply.

25
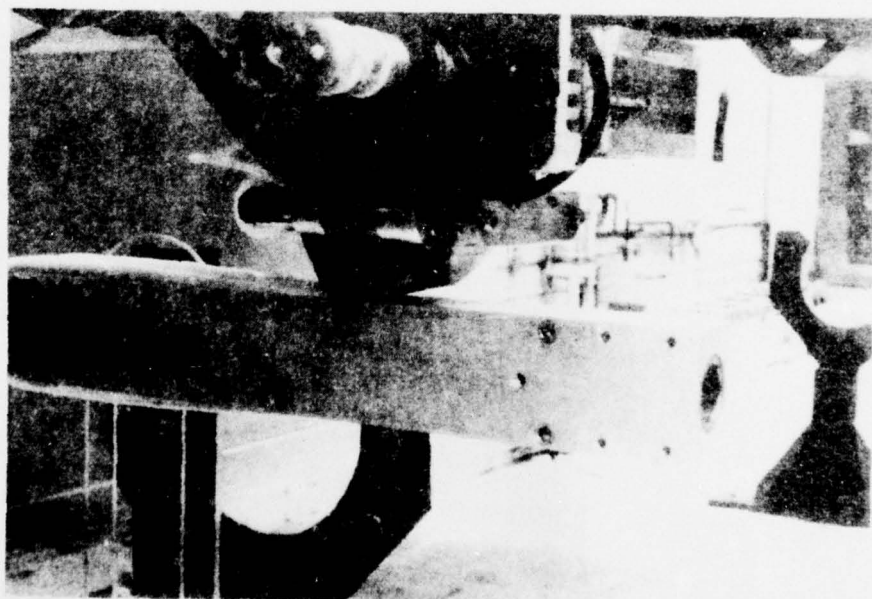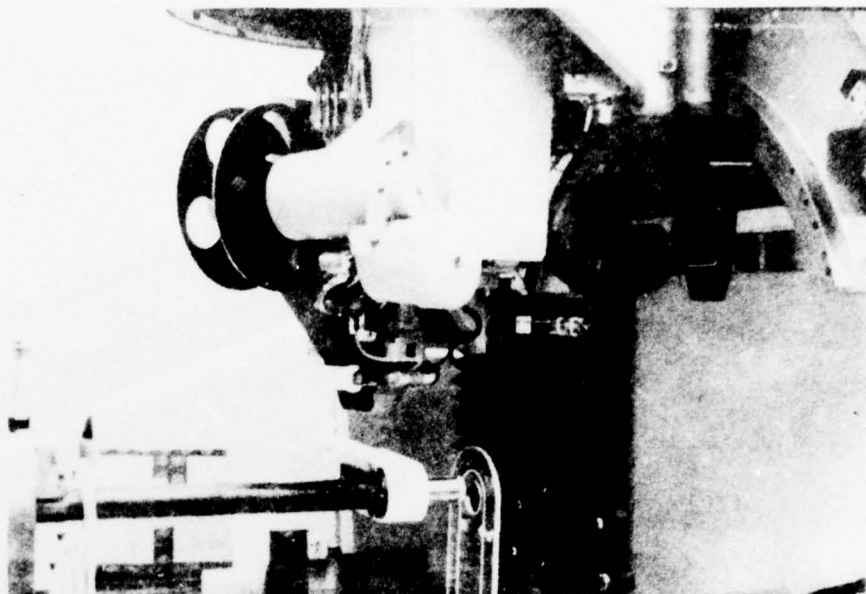
5. Applicator Head Rotating (C-Axis) for Start
   of Next Ply.
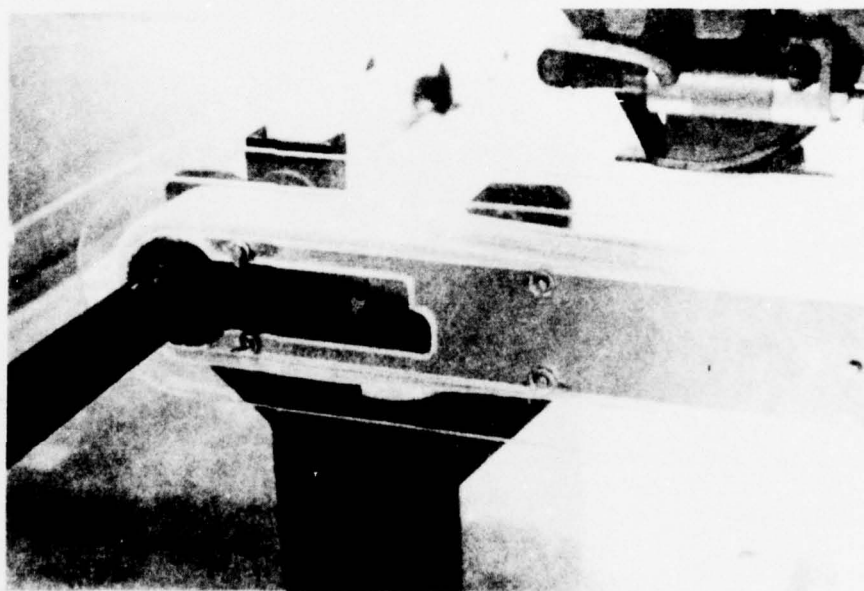
6. "Propeller Wrap" on Mandrel Showing Taper of Plies.
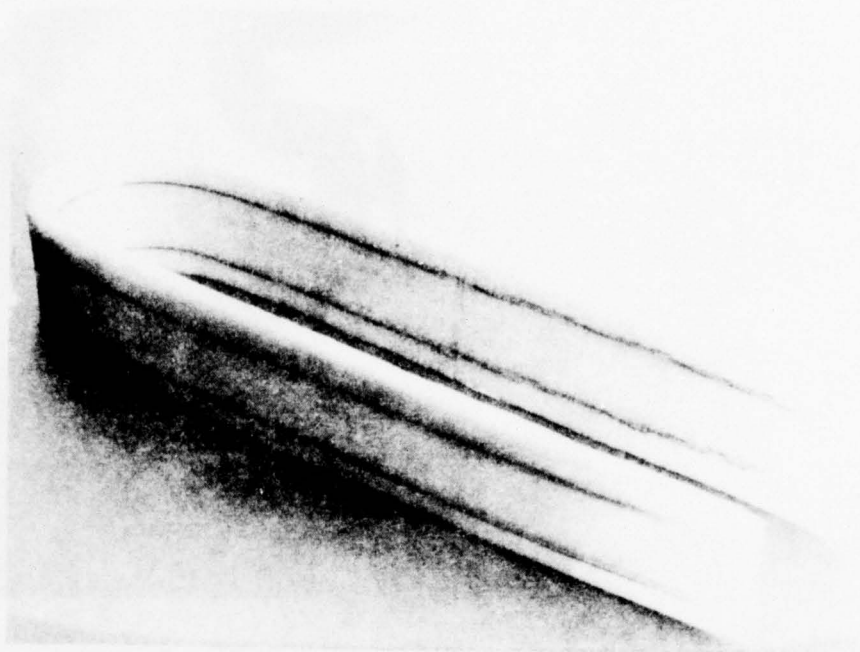
7. Completed "Propeller Wrap" - First 50 Plies of "Root Loop".
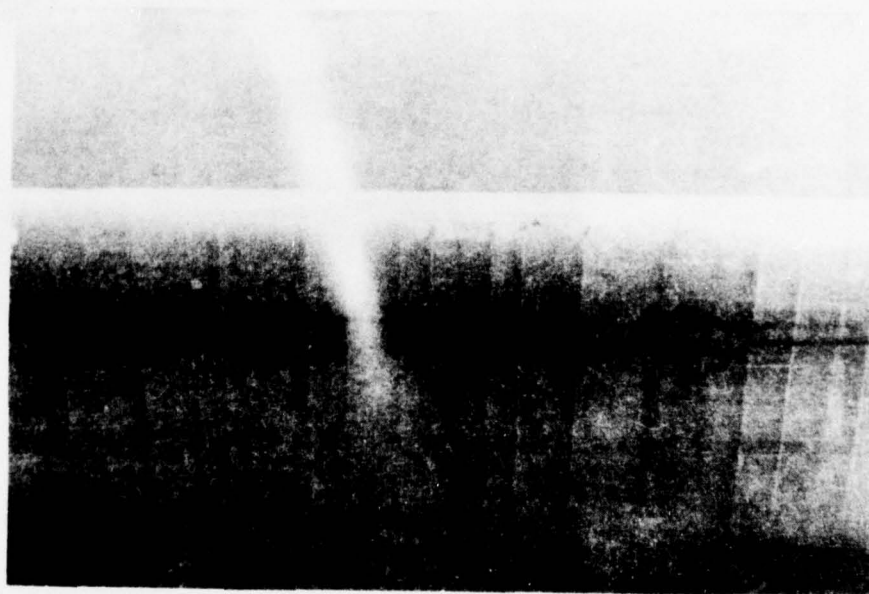
8. Close Up of Inside of "Root Loop" Showing Ply Ends.

27
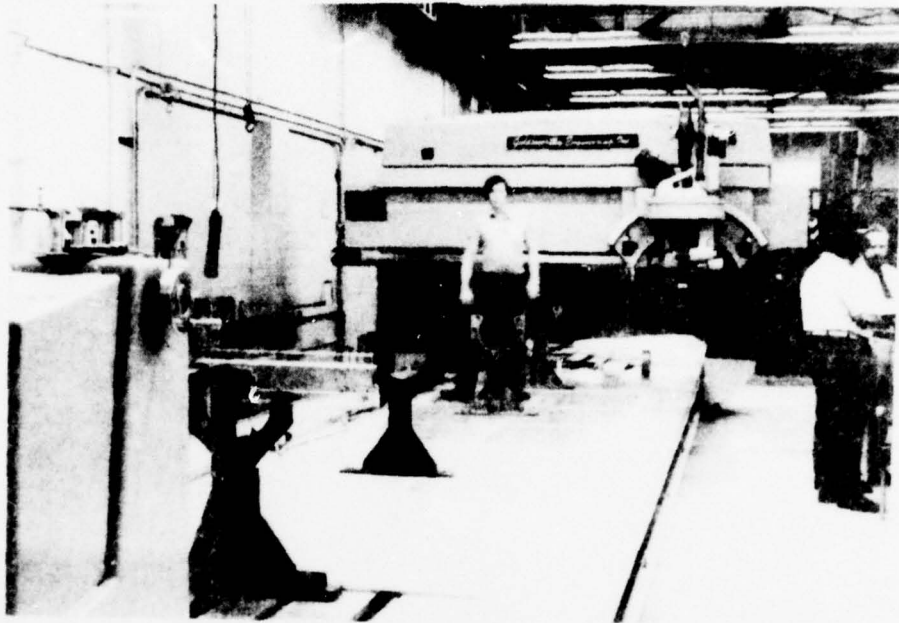
9. View Down Length of Machine Showing Mandrel Steady Rest for Plies 51 Through 144.

APPENDIX B

OPERATING INSTRUCTIONS FOR THE

ATLS SOFTWARE SYSTEM

29

TABLE OF CONTENTS
for Appendix B

OPERATING INSTRUCTIONS FOR THE ATLS SOFTWARE SYSTEM

1. INTRODUCTION

All program modules associated with this software system run under
the control of the PDP-11 Disk Operating System (DOS). Any discussion of
the operational characteristics of the ATLS software system must necessarily
contain some references to the host computer operation system. However,
every attempt has been made to keep these references to a minimum.

Programs are initiated under the DOS system via the RUN command to
the monitor. The system prompts the user by printing a dollar sign ($)
and the user responds by typing in "RUN" followed by the program name.
To execute program ATLSLI, the console display would contain the following:

$RUN ATLSLI

Each program then carries on a dialogue with the user in order to
obtain additional input before beginning execution. Each dialogue will
be described in detail along with the individual program operational des-
criptions.

The remainder of this text will contain detailed operational instruc-
tions for each of the five main program modules. Each of these will con-
tain the following information:

- Program name
- Significant file information
- Operator command
- Input formats
- Output formats
- Error messages
- Program termination conditions

31

2. ATLSGR - ATLS Graph

2.1 Files

logical default name	filename	purpose
IN	DK:ATLS.DAT	Control tape input file.

2.2 User Commands (at CRT)

D   Draw the control tape using the current projective transformation parameters.

C   Center the picture. The graphics cursor is moved to the new center and any character is hit on the keyboard.

S   Scale the picture. The graphics cursor is used to define diagonal corners of the picture area that is to be expanded to the entire viewing area.

Xn   Rotate the figure about the X axis by n degrees. n may be negative.

Yn   Rotate the figure about the Y axis.

Zn   Rotate the figure about the Z axis.

Hn   Reset the eyepoint viewing distance. Original value is 12.0.

M   Mark or save the current transformation parameters.

R   Restore the transformation parameters to the values last marked (see M).

O   Restore the transformation parameters to their initial (original) values.

Vn   Define the virtual size of the viewing screen area. Initially this value is 6.0.

E   Exit or terminate program execution.

2.3 Input Formats

EIA or ASCII ATLS control tape.

2.4 Output Formats

See Appendix D

2.5 Error Messages

INVALID COMMAND

2.6 Program Termination

Upon encountering an "E" command.

33

3.   ATLSLI - ATLS List

   3.1   Files

      logical
      dataset   default
      name   filename   purpose
      IN   DK:ATLS.DAT   Control tape input file.
      6   DK:FOR006.DAT   Listing output file.
      15   KB:FOR015.DAT   Operator command input file.
      16   KB:FOR016.DAT   Operator output log file.

   3.2   Operator Commands   (Console Dialogue)

      $ RUN ATLSLI
      ENTER TITLE...CH47 ROOT LOOP
      ENTER LISTING FILENAME....LP:

   3.3   Input Formats

      EIA or ASCII ATLS control tape.

   3.4   Output Formats

      Each page of the output list contains the following information:

      •   Page Header
           1.   Title entered by operator.
           2.   Current date and time.
           3.   Page number.
           4.   Column headings.
      •   Data Lines
           1.   An entry for each of the permissable control
                code characters (N,G,M,S,X,Y,Z,A,C,D,I,J,K and F)
                within this block.
           2.   A tape block sequence number.

   3.5   Error Messages

      None

3.6   Program Termination

Program terminates after listing a single control tape file.

4.   PLYGEN - Ply Generator

    4.1   Files

        logical
        dataset   default
        name   filename   purpose

        2   DK:FOR002.DAT   Control tape output file
                                             for "propeller wrap."
        3   DK:FOR003.DAT   Control tape output file
                                             for "flip wrap"
        5   DK:FOR005.DAT   Language card input.
        6   DK:FOR006.DAT   List file output.
        16   KB:FOR016.DAT   Operator log output file.

    4.2   Operator Commands   (Console Dialogue)

        $ RUN PLYGEN

    4.3   Input Formats

        The PLYGEN part and mandrel description language is punched
        on cards with one statement per card. Cards with an asterisk
        (*) in column 1 are printed on the output listing but other-
        wise ignored. This allows comments within the listing. Blank
        characters are totally ignored in the syntax analysis and can
        therefore be used freely to improve readability.

        There are twelve types of language statemnets that can be
        input. Each will be described separately.

    4.3.1 END

        One card of this type appears as the last card of the deck.

    4.3.2 THICKNESS n

        Specifies the nominal fiberglass tape thickness in inches.

    4.3.3 MANDREL(1) x,y,z,d

        Specified the mandrel parameters for the first style of
        wrapping geometry. The center of the round end of the tooling

is specified by x,y,z. The pullout point on the x axis
is specified by p. The backup point is specified by b.
The windup point is specified by w.

4.3.5 <u>INITIAL (1) x,y,z</u>

Specifies an optional initial move for the type 1 wrap.

4.3.6 <u>INITIAL (2) x,y,z</u>

Specifies an optional move for the type 2 wrap.

4.3.7 <u>FINAL (1) x,y,z</u>

Specifies an optional final move for the type 1 wrap.

4.3.8 <u>FINAL (2) x,y,z</u>

Specifies an optional final move for the type 2 wrap.

4.3.9 <u>REFSTATION n</u>

Specifies the reference station coordinate from the print.

4.3.10 <u>PLY n,1</u>

Specifies the parameters for a specific reference ply. n
is the ply number and 1 is the station at which that ply
ends. A series of two or more of these cards specify the
plies of a root strap component. Ply 1 and the last ply
must be specified. Ply numbers that are not specified are
calculated from the next higher and lower specified para-
meters assuming a linear increase in ply length.

4.3.11 <u>BREAK n</u>

Specifies the ply number at which part 2 starts.

37

4.3.12 CYLTRAVEL t

Specifies how much travel is allowed in the air cylinder in the head of the ATLS.

4.4 Output Formats

Program listing containing:

- Page Header
    1. PLYGEN identification and version.
    2. Date and time.
    3. Page number.
- An image of the input line containing a sequence number.

4.5 Error Messages

ERRORn

4.6 Program Termination

PLYGEN terminates normally after generating the two control tapes. If errors were detected in reading input cards, PLYGEN terminates abnormally.

5.   PTDUMP - Punched Tape Dump

    5.1   Files

        logical
        dataset   default
        name   filename   purpose
        IN   DK:ATLS.DAT   Control tape input file.
        OUT   PT: Paper tape output file.
        15   KB:FORO15.DAT   Operator command input.
        16   KB:FORO16.DAT   Operator log output.

    5.3   Operator Commands   (Console Dialogue)

        $ RUN PTDUMP
        ENTER LEADER STRING
        CH47 ROOT LOOP

    5.3   Input Formats

        EIA or ASCII ATLS control tape.

    5.4   Output Formats

        ASCII punched paper tape with man-readable leader.

    5.5   Error Messages

        None

    5.6   Program Termination

        After punching one tape.

6. PTLOAD - Punched Tape Loader

6.1 Files

logical
dataset   default
name   filename   purpose

IN   DK:ATLS.DAT   Control tape input.
6   DK:FORO06.DAT   Control tape output.
15   KB:FORO15.DAT   Operator command input file.
16   KB:FORO16.DAT   Operator log output file.

6.2 Operator Commands (Console Dialogue)

$ ASSIGN, PR:, IN
$ RUN PTLOAD
ENTER OUTPUT FILENAME...TEST.DAT
127 RECORDS COPIED

6.3 Input Formats

EIA or ASCII ATLS control tape.

6.4 Output Formats

EIA or ASCII ATLS control tape.

6.5 Error Messages

None

6.6 Program Termination

After reading one tape.

APPENDIX C

PROGRAM DESCRIPTIONS FOR
ATLS SOFTWARE SYSTEM

TABLE OF CONTENTS

for Appendix C

PROGRAM DESCRIPTIONS FOR ATLS SOFTWARE SYSTEM

1. INTRODUCTION

The following text contains a description of each distinct module within the ATLS Software System. Each module description will contain the following information:

- Name of the subroutine or main program.
- Concise statement of purpose.
- Calling sequence and argument description (not applicable for main programs).
- Modules that call this subroutine (not applicable for main programs).
- Subroutines called.
- Diagnostics issued.
- Detailed description of methodology.
- Symbolic source listing.

Five different types of software modules were used in the ATLS programming system:

1. Main programs developed under this contract.
2. Subroutines developed under this contract.
3. Subroutines from a general utility library developed by IITRI.
4. Subroutines from a general utility library supplied with the PDP-11 by Digital Equipment Corporation.
5. Subroutines from a graphics terminal support library supplied by Tektronix Inc.

Only the program modules from categories 1 and 2 above will be described in full detail. Modules from categories 3, 4, and 5 will be described only by name and a concise statement of purpose. This minimum amount of information is required to understand the program listings for categories 1 and 2.

2.   MAIN PROGRAMS

2.1   ATLSGR - ATLS Graph

Purpose: Provide a pictorial representation of the three linear
head motions (x,y,z) that would be taken by the ATLS if it were presented
with the control tape used as input.

Calling Sequence and Arguments: N.A.

Called By: N.A.

Subroutines Called:

INITT	SWINDO
ERASE	VWINDO
MOVABS	MOVEA
MSG	DRAWA
ANSWER	GET
SETUP	R8MULT
BELL	CHAR
	RESET

Diagnostics: None

Detailed Description: Subroutine SETUP is called to perform a pre-
scan of the control tape file and initialize the various matrices associ-
ated with the graphic transformations used within the main program loop.
Several graphics support subroutines are then called to initialize the
graphics package, erase the viewing screen and draw a box that outlines
the viewing area.

The control tape file is scanned and each block of data is converted
to internal representation. If x, y, or z codes exist within the currently
assembled block, a call is made to the graphics subroutines to draw a line
to this new point. After the entire control tape is processed, subroutine
RESET is called to interact with the operator and accept new projection
parameters. From that subroutine, the operator may elect to terminate the
main program.

44

```
        CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        C                                                                C
        C    PROGRAM "ATLSGR" GRAPHS AN ATLAS CONTROL TAPE ON THE        C
        C    TEKTRONICS TUBE...                                          C
        CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        C

0001          IMPLICIT INTEGER (A-W)
0002          BYTE YES,ANSBUF(24)
0003          INTEGER MARK(17),IVALUE(4),GCODES(16)
0004          REAL*4 RVALUE(17),PVECT(2),VECT(6)
0005          REAL*4 VMIN,VDELTA
0006          REAL*8 T(4,4),S(4,4),P(4,4),SDTM(4,4),V
0007          REAL*8 CVECT(7),OVECT(7)
0008          LOGICAL SCANSW,EIAFLG,G04SW,FIRST
        C
0009          COMMON/GETCOM/N,MARK,IVALUE,RVALUE,GCODES,IC
0010          COMMON/CHRCOM/SCANSW,EIAFLG
0011          COMMON/SDTMCA/T,S,P,SDTM,V
0012          COMMON       MODE(3),G04SW
        C
0013          DATA DEBUG/0/,YES/'Y'/
        C
0014          CALL INITT
0015          CALL ERASE
0016          CALL MOVABS(0,700)
        C     CALL MSG('DEBUGGING?')
        C     CALL ANSWER(ANSBUF)
        C     IF(ANSBUF(1).EQ.YES) DEBUG=1
        C
0017          CALL SETUP(DEBUG)
0018          CALL SWINDO(280,743,36,743)
0019          CALL MOVABS(280,36)
0020          CALL DRWABS(280,779)
0021          CALL DRWABS(1023,779)
0022          CALL DRWABS(1023,36)
0023          CALL DRWABS(280,36)
0024          CALL RESET
0025          CALL ERASE
0026          CALL BELL
0027          SCANSW=.TRUE.
0028          FIRST=.TRUE.
0029          VMIN=-V/2.0D0
0030          VDELTA=V
0031          CALL VWINDO(VMIN,VDELTA,VMIN,VDELTA)
0032          CALL MOVABS(280,36)
0033          CALL DRWABS(280,779)
0034          CALL DRWABS(1023,779)
0035          CALL DRWABS(1023,36)
0036          CALL DRWABS(280,36)
0037          DO 3 I=1,6
0038          VECT(I)=0.0
0039    3     CALL GET
0040    10    IF(MARK(3).LE.0) GO TO 20
```

45

```
0041        IF(IVALUE(3).EQ.62) FIRST=.FALSE.
0042        IF(IVALUE(3).EQ.02 .OR.
           1   IVALUE(3).EQ.03 .OR.
           2   IVALUE(3).EQ.30    ) GO TO 90
0043   20   MCOUNT=0
0044        DO 21 I=1,6
0045        II=I+4
0046        MCOUNT=MCOUNT+MARK(II)
0047   21   IF(MARK(II).GT.0) VECT(I)=RVALUE(II)
0048        IF(MCOUNT.LE.0) GO TO 10
0049   C
       C    SETUP VECTOR AND TRANSFORM.
0050   30   DO 31 I=1,3
0051   31   CVECT(I)=VECT(I)
            CVECT(4)=1.0D0
0052        CALL R8MULT(CVECT,SDTM,OVECT,1,4,4)
0053        DO 32 I=1,4
0054        OVECT(I)=OVECT(I)/OVECT(4)
0055   32   IF(I.LE.2) PVECT(I)=OVECT(I)
0056        IF(FIRST.EQ..FALSE.) CALL DRAWA(PVECT(1),PVECT(2))
0057        IF(FIRST.EQ..TRUE. ) CALL MOVEA(PVECT(1),PVECT(2))
0058        IF(DEBUG.NE.0) WRITE(6,900)(CVECT(L),L=1,4),PVECT
0059        GO TO 10
       C
       C    SCAN FOR END OF FILE AND TALK TO THE OPERATOR.
       C
0060   90   IF(CHAR().GE.0) GO TO 90
0061        SCANSW=.TRUE.
0062        CALL RESET
0063        GO TO 1
       C
0064  900   FORMAT(/4(D16.8)/2(E16.8))
0065        E N D
```

```
ROUTINES CALLED:
INITT , ERASE , MOVABS, SETUP , SWINDO, DRWABS, RESET
BELL  , VWINDO, GET  , R8MULT, DRAWA , MOVEA , CHAR

OPTIONS =/ON,/OP:1

BLOCK    LENGTH
MAIN.    722    (0002644)*
.$$$.    4      (0000010)
GETCOM   73     (0000222)
CHRCOM   2      (0000004)
SDTMCA   260    (0001010)

**COMPILER ----  CORE**
         PHASE    USED   FREE
DECLARATIVES   00622 14434
EXECUTABLES    01304 13752
ASSEMBLY       01535 18161
```

2.2 ATLSLI - ATLS List

Purpose: To provide a conveniently readable formatted listing of an ATLS control tape.

Calling Sequence and Arguments: N.A.

Called By: N.A.

Subroutines Called:

DATE	FILL
TIME	GET
ASSIGN	MOVB
DELETE	EXIT

Diagnostics: None.

Detailed Description: A dialog is carried on with the operator to accept information about the listing file name and a title string. The control tape file is then scanned and each block of data is assembled into internal format. A line is formatted for printing using the ENCODE facility of the PDP-11 FORTRAN system. Each line is then printed along with a sequential reference number. The header is printed at the top of each page of output along with a page number. When the entire control tape file is processed, this program returns control to the operating system.

```
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C                                                                         C
      C     PROGRAM "ATLSL1" PRODUCES FORMATTED LISTINGS OF ATLAS              C
      C     CONTROL TAPES ON THE LINE PRINTER.                                  C
      C                                                                         C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C
0001        IMPLICIT INTEGER (A-Z)
0002        BYTE TITLE(70)
0003        INTEGER MARK(17),IVALUE(4),GCODES(16)
0004        INTEGER LPBUF(66),LPBUFX(8)
0005        REAL HEADER(5)
0006        REAL RVALUE(17)
0007        LOGICAL SCANSW,EIAFLG,G04SW
      C
0008        COMMON/GETCOM/N,MARK,IVALUE,RVALUE,GCODES,IC
0009        COMMON/CHRCOM/SCANSW,EIAFLG
0010        COMMON        MODE(3),G04SW
      C
0011        DATA MAXLIN/50/
0012        DATA HEADER/4H        ,4H      ,4H      ,4H       ,4H       /
      C
      C
      C     DO SOME INITIALIZATION
      C
0013        CALL DATE(HEADER)
0014        CALL TIME(HEADER(4))
0015        CALL ASSIGN(15,'KB:',0)
0016        CALL ASSIGN(16,'KB:',0)
0017        WRITE(16,918)
0018        READ(15,919) TITLE
0019        WRITE(16,915)
0020        READ (15,916)LPBUF
0021        CALL ASSIGN(6,LPBUF,40)
0022        CALL DELETE(6)
      C
0023        CALL FILL(1.,MODE,,3)
0024        FORM=' ,
0025        LINENO=0
0026        PAGENO=0
0027        SCANSW=.TRUE.
0028        LINES=MAXLIN
      C
0029        CALL GET
0030        IF(EIAFLG.EQ..TRUE.) WRITE(16,902)
0031        IF(EIAFLG.EQ..FALSE.) WRITE(16,903)
      C
      C     MAIN SCAN LOOP STARTS HERE.
      C
0032   90   M2=MARK(2)
0033        IF(M2.LE.0) GO TO 100
0034        DO 92 I=1,M2
0035        G=GCODES(I)
0036        IF(G.EQ.00) MODE(1)=1
0037        IF(G.EQ.01) MODE(1)=2
```

```
0038        IF(G.EQ.02) MODE(1)=3
0039        IF(G.EQ.03) MODE(1)=4
0040        IF(G.EQ.17) MODE(2)=1
0041        IF(G.EQ.18) MODE(2)=2
0042        IF(G.EQ.19) MODE(2)=3
0043        IF(G.EQ.90) MODE(3)=1
0044        IF(G.EQ.91) MODE(3)=2
0045    92  CONTINUE
        C
0046   100  LINES=LINES+1
0047        IF(LINES.LT.(MAXLIN-1)) GO TO 101
0048        IF(LINES.LE.MAXLIN .AND. MARK(1).LE.0) GO TO 101
0049        PAGENO=PAGENO+1
0050        WRITE(6,904)FORM,TITLE,HEADER,PAGENO
0051        FORM=' '
0052        LINES=1
0053   101  CALL FILL('  ',LPBUF,,66)
0054        IF(MARK(1).GT.0) WRITE(6,917)
0055        IF(MARK(1).GT.0) LINES=LINES+1
        C
        C   ENCODE EACH OF THE FIELDS.
        C
0056        IF(MARK(1).NE.0)  ENCODE(10,906,LPBUFX)IVALUE(1)
0057        IF(MARK(1).NE.0)  CALL MOVB(LPBUFX,,LPBUF,1,4)
0058        IF(MARK(2).NE.0)  ENCODE(10,907,LPBUFX)IVALUE(2)
0059        IF(MARK(2).NE.0)  CALL MOVB(LPBUFX,,LPBUF,6,2)
0060        IF(MARK(3).NE.0)  ENCODE(10,907,LPBUFX)IVALUE(3)
0061        IF(MARK(3).NE.0)  CALL MOVB(LPBUFX,,LPBUF,9,2)
0062        IF(MARK(4).NE.0)  ENCODE(10,908,LPBUFX)IVALUE(4)
0063        IF(MARK(4).NE.0)  CALL MOVB(LPBUFX,,LPBUF,12,3)
0064        IF(MARK(5).NE.0)  ENCODE(10,909,LPBUFX)RVALUE(5)
0065        IF(MARK(5).NE.0)  CALL MOVB(LPBUFX,,LPBUF,16,9)
0066        IF(MARK(6).NE.0)  ENCODE(10,909,LPBUFX)RVALUE(6)
0067        IF(MARK(6).NE.0)  CALL MOVB(LPBUFX,,LPBUF,26,9)
0068        IF(MARK(7).NE.0)  ENCODE(10,909,LPBUFX)RVALUE(7)
0069        IF(MARK(7).NE.0)  CALL MOVB(LPBUFX,,LPBUF,36,9)
0070        IF(MARK(8).NE.0)  ENCODE(10,909,LPBUFX)RVALUE(8)
0071        IF(MARK(8).NE.0)  CALL MOVB(LPBUFX,,LPBUF,46,9)
0072        IF(MARK(9).NE.0)  ENCODE(10,910,LPBUFX)RVALUE(9)
0073        IF(MARK(9).NE.0)  CALL MOVB(LPBUFX,,LPBUF,36,9)
0074        IF(MARK(10).NE.0) ENCODE(10,909,LPBUFX)RVALUE(10)
0075        IF(MARK(10).NE.0) CALL MOVB(LPBUFX,,LPBUF,66,9)
0076        IF(MARK(11).NE.0) ENCODE(10,909,LPBUFX)RVALUE(11)
0077        IF(MARK(11).NE.0) CALL MOVB(LPBUFX,,LPBUF,76,9)
0078        IF(MARK(12).NE.0) ENCODE(10,909,LPBUFX)RVALUE(12)
0079        IF(MARK(12).NE.0) CALL MOVB(LPBUFX,,LPBUF,86,9)
0080        IF(MARK(13).NE.0) ENCODE(10,909,LPBUFX)RVALUE(13)
0081        IF(MARK(13).NE.0) CALL MOVB(LPBUFX,,LPBUF,96,9)
0082        IF(MARK(14).NE.0) ENCODE(10,910,LPBUFX)RVALUE(14)
0083        IF(MARK(14).NE.0 .AND. G04SW.EQ..TRUE.)
       1    CALL MOVB(LPBUFX,,LPBUF,106,9)
0084        IF(MARK(14).NE.0 .AND. G04SW.EQ..FALSE.)
       1    ENCODE(10,909,LPBUFX)RVALUE(14)
0085        IF(MARK(14).NE.0 .AND. G04SW.EQ..FALSE.) CALL MOVB(LPBUFX,,LPBUF,106,9)
0086        IF(MARK(15).NE.0) CALL MOVB('/',,LPBUF,,1)
0087        LINENO=LINENO+1
```

49

```
0088          ENCODE(10,911,LPBUFX)LINENO
0089          CALL MOVB(LPBUFX,,LPBUF,127,5)
0090          ENCODE(10,913,LPBUF,122,5)
0091          IF(IC.NE.0) CALL MOVB(LPBUFX,,LPBUF,122,5)
0092          WRITE(6,905)LPBUF
0093          IF(M2.LT.2) GO TO 105
0094          DO 103 I=2,M2
0095          LINES=LINES+1
0096          IF(LINES.LE.MAXLIN) GO TO 103
0097          PAGENO=PAGENO+1
0098          WRITE(6,904)FORM,TITLE,HEADER,PAGENO
0099          LINES=1
0100   103    WRITE(6,912)GCODES(I)
0101   105    IF(MARK(3).LE.0) GO TO 106
0102          IF(IVALUE(3).EQ.02 .OR.
0103         1    IVALUE(3).EQ.03 .OR.       ) GO TO 800
0104         2    IVALUE(3).EQ.30          ) GO TO 800
0103   106    CALL GET
0104          GO TO 90
0105   C
0106   C      END OF TAPE PROCESSING..
0107   C
0105   800    CALL EXIT
0106   C
0107   C      FORMATS
0108   C
0106   902    FORMAT(' TAPE CODE IS EIA'/)
0107   903    FORMAT(' TAPE CODE IS ASCII'/)
0108   904    FORMAT(A1////1X,70A1,'ATLAS CONTROL TAPE LIST ',5A4,'   PAGE',
0109         1      14///  N   G   M   S   X-AXIS   Y-AXIS   Z-AXIS',
0110         2      '    A-AXIS   C-AXIS   D-AXIS   I-OFFSET  J-OFFSET',
0111         3      '   K-OFFSET   FEEDRATE'/' **** ** ** ***',10(' *********'))
0109   905    FORMAT(1X,66A2)
0110   906    FORMAT(I4)
0111   907    FORMAT(I2)
0112   908    FORMAT(I3)
0113   909    FORMAT(F9.3)
0114   910    FORMAT(F9.2)
0115   911    FORMAT(I5)
0116   912    FORMAT(6X,'!',I2)
0117   913    FORMAT('!',I3,'!')
0118   915    FORMAT('$ENTER LISTING FILENAME....')
0119   916    FORMAT(66A2)
0120   917    FORMAT(2X,131('-'))
0121   918    FORMAT('$ENTER TITLE....')
0122   919    FORMAT(70A1)
0123          E N D
```

```
50

ROUTINES CALLED:
DATE  , TIME  , ASSIGN, DELETE, FILL  , GET   , MOVB
EXIT

OPTIONS =/ON,/OP:1

BLOCK       LENGTH
MAIN.    1911    (007356)*
.####.      4    (000010)
GETCOM     73    (000222)
```

2.3 PLYGEN - Ply Generator

<u>Purpose</u>: To generate ATLS control tapes for a specific configuration of a CH47-style root strap component.

<u>Calling Sequence and Arguments</u>: N.A.

<u>Called By</u>: N.A.

<u>Subroutines Called</u>:

CMPB	MOVE
DELETE	HEAD
ASSIGN	CLAMP
FILLB	SHEAR
DATE	SQRT
TIME	EOT
MOVB	ABS
ERR	SLIT
BOT	DELAY
BUILD	EXIT
PUNCH	

<u>Diagnostics</u>: Error 1 - More than 256 ply description cards.

    " 2 - Less than 2 ply description cards.

    " 3 - Ply Number 1 not specified.

    " 4 - Ply lengths decreasing

    " 5 - Ply lengths not increasing fast enough.

    " 6 - 2 ply description cards for the same ply.

    " 7 - Undefined input card.

<u>Detailed Description</u>: PLYGEN reads input cards that describe various variable parameters for a CH47-style root strap and produces two ATLS control tapes to be used for laying-up this component. For shorter plies, a "propellor-wrap" type of wrapping geometry is generated. This type of wrap is used for the first plies (typically 50 or so) layed up. The remainder of the longer plies are layed up using a "flip-wrap" style of wrapping geometry. This style wrap is generated for the second control tape.

The program proceeds in three basic phases:

1. Input parsing and preliminary error checking phase.

2. Generate the first control tape for the first plies.

3. Generate the other control tape for the remaining plies.

The input phase reads input cards, identifies the statement type, and dispatches to a separate routine to decode each individual statement. This continues until an "END" card is encountered. The various parameters that were collected during the input phase are checked for semantic consistancy and appropriate error diagnostics are issued if problems are detected. All errors except for ERROR-7 cause PLYGEN to terminate at the end of the input phase.

Phase 2 starts by initializing the control tape file and generating some preliminary move data. The internal ply table is then scanned and each ply is generated in turn. As each ply is generated, the mandrel shape logically changes for subsequent plies. This is allowed for by the program and a piecewise linear approximation of the current mandrel shape is used to generate each ply. This process continues until all plies up to the ply specified by the "BREAK" card is generated. Trailer codes are then punched and the first control tape file is closed out.

Phase 3 generates the second control tape file using the "flip-wrap" style geometry. This control tape file is opened and initialized in a similar fashion as the previous phase. The scanning of the ply information table then continues where previously left off with this new wrapping geometry. As in the previous phase, piecewise linear approximations and allowance for continuous ply buildup is automatically handled by the program. After the ply table is exhausted, this second control tape file is closed out and the program terminates.

```
        CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C                                                                C
      C        PROGRAM "PLYGEN".....                                   C
      C                                                                C
      C        PROGRAM TO GENERATE TAPE FOR ATLAS FOR CH47 ROOT STRAP  C
      C        LAYUP.                                                   C
      C                                                                C
        CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C
0001  C; NUMBER OF PLY THICKNESSES AT THIS REFERENCE POINT.
           INTEGER PLYNUM(256)
0002  C; LENGTH OF THE PLY FOR THE CORRESPONDING ENTRY IN THE "PLYNUM" TABLE.
           REAL PLYLEN(256),SAVLEN
0003  C; NUMBER OF ENTRIES IN "PLYNUM" AND "PLYLEN".
           INTEGER PLYMAX
0004  C; FIRST PLY NUMBER OF "PART 2".
           INTEGER P2MIN
0005  C; CURRENT REFERENCE PLY INDEX.
           INTEGER PLY
0006  C; FIBERGLASS TAPE THICKNESS.
           REAL THICK
0007  C; MANDREL CENTER CO-ORDINATES (FOR MANDREL 1).
           REAL XM,YM,ZM
0008  C; MANDREL RADIUS AND DIAMETER.
           REAL RM,DM
0009  C; OVERTRAVEL, FLIP, AND WINDUP PARAMETERS FOR PART 2.
           REAL PULOUT,BACKUP,WINDUP
0010  C; MANDREL CENTER CO-ORDINATES (FOR MANDREL 2).
           REAL XM2,YM2,ZM2
0011  C; REFERENCE STATION CO-ORDINATE (FROM THE DRAWING.)
           REAL REFSTN
0012  C; Z CO-ORDINATE OF TOP EDGE OF MANDREL.
           REAL BASE
0013  C; Z CO-ORDINATE OF TOP EDGE OF MANDREL (ADJUSTED FOR 1/2 OF TRAVEL).
           REAL TBASE
0014  C; INITIAL HEAD POSITION.
           REAL  X0, Y0, Z0
0015       REAL X20,Y20,Z20
0016  C; FINAL HEAD POSITION.
           REAL XFINAL,YFINAL,ZFINAL
0017       REAL X2FINL,Y2FINL,Z2FINL
0018  C; SOME BOOLEAN FLAGS.
           LOGICAL IFLAG,I2FLAG,FFLAG,F2FLAG,MFLAG,M2FLAG,BFLAG
0019  C; SOME MORE BOOLEAN FLAGS FOR PART 2....
           LOGICAL CFLAG,SFLAG,CBSFLG
0020  C; PNEUMATIC CYLINDER TRAVEL FOR HEAD.
           REAL TRAVEL
0021  C; LENGTH OF TAPE BETWEEN SHEAR AND END OF SPATULA.
           REAL SHRLEN
0022  C; DIRECTION INDICATOR. +1 --> +Y DIRECTION,  -1 --> -Y DIRECTION.
           REAL DIR
0023  C; CURRENT PLY NUMBER (1 TO PLYNUM(PLYMAX)) PUNCHED AS NCODE ON TAPE.
           INTEGER NCODE
      C; TAPE LENGTHS IN REGION 1, 2 AND 3.
```

53

```
FORTRAN V06.13              10:13:57    03-OCT-76   PAGE   2

0024        REAL L1,L2,L3
0025   C:  TOTAL LENGTHS OF TAPE.
            REAL TOTLEN(2)
0026   C:  INPUT CARD BUFFER.
            BYTE CARD(80)
0027   C:  LISTING PAGE HEADER ETC.....
            REAL HEADER(5)
0028        INTEGER LINENO,PAGENO,MAXLIN
0029   C:  INTEGER FUNCTION SUBROUTINE TO COMPARE BYTE STRINGS.
            INTEGER CMPB
0030   C:  LOGICAL VARIABLES FOR VARIOUS SUBROUTINE CALLS.
            LOGICAL OFF,ON
0031   C:  SOME CHARACTER CONSTANTS TO BE USED AS BYTES.
            BYTE BLANK,COMMA,STAR,DOLLAR,EQUALS,TAB
0032   C:  A MAGICAL NUMBER.
            REAL PI
       C:
       C:  INITIALIZE SOME OF THE ABOVE.
       C
0033        DATA OFF,ON/.FALSE.,.TRUE./
0034        DATA PI/3.14159265/
0035        DATA IFLAG,I2FLAG,FFLAG,F2FLAG,MFLAG,M2FLAG/6*.FALSE./
0036        DATA BLANK,COMMA,STAR,DOLLAR,EQUALS,TAB/' ',',','*','$','=',9/
0037        DATA MAXLIN/50/
       C
       C   SETUP DEFAULTS.
       C
0038        THICK=0.009
0039        XM=0.0
0040        YM=0.0
0041        ZM=0.0
0042        TRAVEL=1.0
0043        SRHLEN=13.54
0044        REFSTN=0.0
       C
       C   INITIALIZE SOME OTHER STUFF.
       C
0045        CALL DELETE(6)
0046        CALL ASSIGN(16,'KB:',0)
0047        PLYMAX=0
0048        RM=0.0
0049        DM=0.0
0050        DIR=-1.0
0051        P2MIN=-1
0052        CALL FILLB(' ',HEADER,,20)
0053        CALL DATE(HEADER(1))
0054        CALL TIME(HEADER(4))
0055        PAGENO=1
0056        LINENO=MAXLIN
0057        NCARD=0
0058        TOTLEN(1)=0.0
0059        TOTLEN(2)=0.0
       C
       C   INPUT PHASE.
       C
```

54

```
FORTRAN V06.13                    10:13:57    03-OCT-76    PAGE    3

0060   10    IF(LINENO.LT.MAXLIN) GO TO 12
0061         WRITE(6,11)HEADER,PAGENO
0062   11    FORMAT(////1X,'PLYGEN V1.0      ',T40,5A4,'    PAGE',I4///)
0063         LINENO=0
0064         PAGENO=PAGENO+1
0065   12    READ(5,13)CARD
0066   13    FORMAT(80A1)
0067         DO 14 I=1,80
0068         J=81-I
0069         IF(CARD(J).NE.BLANK .AND. CARD(I).NE.TAB) GO TO 15
0070   14    CARD(J)=COMMA
0071         GO TO 10
0072   15    IF(CARD(I).NE.STAR) GO TO 17
0073         WRITE(6,16)TAB,(CARD(K),K=1,J)
0074   16    FORMAT(1X,81A1)
0075         LINENO=LINENO+1
0076         GO TO 10
0077   17    NCARD=NCARD+1
0078         WRITE(6,18)NCARD,TAB,(CARD(K),K=1,J)
0079   18    FORMAT(1X,I4,')',81A1)
0080         LINENO=LINENO+1
0081         DO 19 I=1,79
0082         J=80-I
0083 1999    IF(CARD(I).NE.BLANK .AND. CARD(I).NE.TAB) GO TO 1998
0084         CALL MOVB(CARD(I),1,CARD(I),0,3)
0085         GO TO 1999
0086 1998    IF(CARD(I).EQ.EQUALS) CARD(I)=COMMA
0087   19    CONTINUE
      C
0088         IF(CMPB('THICKNESS' ,CARD, 9 ).EQ.0) GO TO 20
0089         IF(CMPB('MANDREL(1)',CARD,10 ).EQ.0) GO TO 30
0090         IF(CMPB('MANDREL(2)',CARD,10 ).EQ.0) GO TO 35
0091         IF(CMPB('INITIAL(1)',CARD,10 ).EQ.0) GO TO 40
0092         IF(CMPB('INITIAL(2)',CARD,10 ).EQ.0) GO TO 45
0093         IF(CMPB('PLY'       ,CARD, 3 ).EQ.0) GO TO 50
0094         IF(CMPB('FINAL(1)'  ,CARD, 8 ).EQ.0) GO TO 60
0095         IF(CMPB('FINAL(2)'  ,CARD, 8 ).EQ.0) GO TO 65
0096         IF(CMPB('REFSTATION',CARD,10 ).EQ.0) GO TO 70
0097         IF(CMPB('BREAK'     ,CARD, 5 ).EQ.0) GO TO 80
0098         IF(CMPB('CYLTRAVEL' ,CARD, 9 ).EQ.0) GO TO 90
0099         IF(CMPB('END'       ,CARD, 3 ).EQ.0) GO TO 1000
0100         CALL ERR(7,1)
0101         GO TO 10
      C
      C        TAPE THICKNESS CARD COMES HERE.
      C
0102   20    DECODE(80,21,CARD)THICK
0103   21    FORMAT(9X,F10.0)
0104         GO TO 10
      C
      C        MANDREL PARAMETERS ARE DECODED HERE.
      C
0105   30    DECODE(80,31,CARD)XM,YM,ZM,DM
0106   31    FORMAT(10X,6F11.0)
0107         RM=DM/2.0
0108         MFLAG=.TRUE.
```

```
0109        GO TO 10
0110   35   DECODE(80,31,CARD)XM2,YM2,ZM2,WINDUP,BACKUP,PULOUT
0111        M2FLAG=.TRUE.
0112        GO TO 10
C
C          INITIAL HEAD CO-ORDINATES ARE DECODED HERE.
C
0113   40   DECODE(80,41,CARD)X0,Y0,Z0
0114   41   FORMAT(10X,3F11.0)
0115        IFLAG=.TRUE.
0116        GO TO 10
0117   45   DECODE(80,41,CARD)X20,Y20,Z20
0118        I2FLAG=.TRUE.
0119        GO TO 10
C
C          PLY INFORMATION COMES HERE.
C
0120   50   PLYMAX=PLYMAX+1
0121        IF(PLYMAX.GT.256) CALL ERR(1,0)
0122        DECODE(80,51,CARD)PLYNUM(PLYMAX),PLYLEN(PLYMAX)
0123   51   FORMAT(3X,I6,F10.0)
0124        GO TO 10
C
C          FINAL HEAD POSITION GETS DECODED HERE.
C
0125   60   DECODE(80,61,CARD)XFINAL,YFINAL,ZFINAL
0126   61   FORMAT(8X,3F11.0)
0127        FFLAG=.TRUE.
0128        GO TO 10
0129   65   DECODE(80,61,CARD)X2FINL,Y2FINL,Z2FINL
0130        F2FLAG=.TRUE.
0131        GO TO 10
C
C          REFERENCE STATION CARD COMES HERE.
C
0132   70   DECODE(80,71,CARD)REFSTN
0133   71   FORMAT(10X,F11.0)
0134        GO TO 10
C
C          BREAK CARD PROCESSED HERE.
C
0135   80   DECODE(80,81,CARD)P2MIN
0136   81   FORMAT(5X,I10)
0137        GO TO 10
C
C          CYLINDER TRAVEL CARD COMES HERE.
C
0138   90   DECODE(80,91,CARD)TRAVEL
0139   91   FORMAT(9X,F10.0)
0140        GO TO 10
C
C          END-OF-INPUT PHASE.
C
0141 1090   IF(MFLAG.EQ..FALSE.) CALL ERR(9,0)
0142        IF(PLYMAX.LT.2) CALL ERR(2,0)
0143        DO 1092 I=2,PLYMAX
```

56

```
0144              J=0
0145              DO 1091 K=1,PLYMAX
0146              IF(PLYNUM(K-1).LE.PLYNUM(K)) GO TO 1091
0147              J=1
0148              ITEMP=PLYNUM(K-1)
0149              RTEMP=PLYLEN(K-1)
0150              PLYNUM(K-1)=PLYNUM(K)
0151              PLYLEN(K-1)=PLYLEN(K)
0152              PLYNUM(K)=ITEMP
0153              PLYLEN(K)=RTEMP
0154      1091    CONTINUE
0155              IF(J.EQ.0) GO TO 1093
0156      1092    CONTINUE
0157      C
0158      C       CHECK PLY LENGTHS.
0159      C
0160      1093    IF(PLYNUM(1).NE.1) CALL ERR(3,0)
0161              IF(PLYLEN(1).LT.REFSTN) CALL ERR(4,0)
0162              PLYLEN(1)=PLYLEN(1)-REFSTN
0163              RTEMP=2.0*PLYLEN(1)+P1*RM
0164              IF(RTEMP.LE.SHRLEN) CALL ERR(8,0)
0165              DO 1094 I=2,PLYMAX
0166              PLYLEN(1)=PLYLEN(1)-REFSTN
0167              IF(PLYNUM(I-1).EQ.PLYNUM(I)) CALL  ERR(6,0)
0168              IF(PLYLEN(I-1).LE.PLYLEN(I) .AND. I.EQ.PLYMAX) GO TO 1094
0169              IF(PLYLEN(I-1).GE.PLYLEN(I)) CALL ERR(4,0)
0170              TANGNT=(PLYLEN(I-1)-PLYLEN(I-1))/((PLYNUM(I)-PLYNUM(I-1))*THICK)
0171              IF(TANGNT.LT.3.0) CALL ERR(5,0)
0172      1094    CONTINUE
0173      C
0174      C       CHECK OUT PART 2 PARAMETERS.
0175      C
0176              IF(PULOUT.EQ.0.0 .OR.
0177             +   BACKUP.EQ.0.0 .OR.
0178             +   WINDUP.EQ.0.0 .OR.
0179             +   PULOUT.LT.BACKUP .OR.
0180             +   BACKUP.LT.WINDUP .OR.
                 +   WINDUP.LT.XM2          ) CALL ERR(10,0)
          C
                 WRITE(6, 1095)
                 WRITE(16,1095)
          1095   FORMAT(1X)
          C
          C       DO SOME MORE INITIALIZATION......
          C
                 BASE=ZM+RM
                 TBASE=BASE-TRAVEL/2.0
                 CALL DELETE(2)
          C
          C       DO TAPE PREAMBLE
          C
          100    CALL BOT(2,0)
                 CALL BUILD('G',1)
                 CALL BUILD('G',90)
                 CALL PUNCH
```

57

```
0181        IF(IFLAG.EQ..TRUE.) CALL MOVE(X0,Y0,Z0)
0182        Y=YM-PLYLEN(1)-1.0
0183        Z=BASE+3.0
0184        CALL MOVE(XM,Y,Z)
0185        CALL MOVE(.,.,0.0,270.0,-0.0001)
0186        CALL HEAD(ON)
0187        CALL CLAMP(ON)
       C
       C          LAY PLY #1
0188   200  L1=PLYLEN(1)
0189        L2=P1*RM
0190        L3=L1
0191        TOTLEN(1)=TOTLEN(1)+L1+L2+L3
       C
0192        PLY=1
0193        BFLAG=.TRUE.
0194        IF(P2MIN.LE.0 .AND. SHRLEN.LT.L3+0.5) GO TO 400
       C
0195        ITYPE=1
0196        IF(SHRLEN.LT.L2+L3) ITYPE=2
0197        IF(SHRLEN.LT.   L3) ITYPE=3
       C
       C          DO PLY #1 SEGMENT 0.
       C
0198        NCODE=1
0199        Z=BASE+1.0
0200        CALL MOVE(.,.Z,...,NCODE)
0201        Y=YM-PLYLEN(1)
0202        CALL MOVE(.,Y,BASE)
0203        CALL MOVE(.,.,TBASE)
0204        CALL CLAMP(OFF)
       C
       C          DO PLY #1 SEGMENT 1.
0205   210  IF(ITYPE.NE.1) GO TO 215
0206        Y=YM-(SHRLEN-L2-L3)
0207        CALL MOVE(.,Y)
0208        CALL SHEAR
0209   215  CALL MOVE(.,YM)
       C
       C          DO PLY #1 SEGMENT 2.
0210   220  IF(ITYPE.NE.2) GO TO 225
0211        D=180.0*(L2+L3-SHRLEN)/L2
0212        CALL MOVE(.,.,.,D)
0213        CALL SHEAR
0214   225  CALL MOVE(.,.,.,180.0)
       C
       C          DO PLY #1 SEGMENT 3.
0215   230  IF(ITYPE.NE.3) GO TO 235
0216        Y=YM+(PLYLEN(1)-SHRLEN)
0217        CALL MOVE(.,Y)
0218   235  CALL SHEAR
0219        Y=YM+PLYLEN(1)
0220        CALL MOVE(.,Y)
       C
       C          DO PLY #1 SEGMENT 4.
```

58

```
0221    240     CALL CLAMP(ON)
0222            Z=BASE+THICK
0223            CALL MOVE(.,Z)
0224            Y=Y+1
0225            Z=BASE+1
0226            CALL MOVE(,Y,Z)
0227            Z=Z+2
0228            CALL MOVE(.,Z)
        C
        C       LAY THE REST OF THE "PART 1"  PLIES BY STEPPING THROUTH THE PLY TABLES
        C
0229    300     DO 380 PLY=2,PLYMAX
0230            N1=PLYNUM(PLY-1)+1
0231            N2=PLYNUM(PLY)
0232            M2=PLY-1
0233            YINC=(PLYLEN(PLY)-PLYLEN(PLY-1))/(N2-(N1-1))
        C
        C       TEMPORARILY SAVE THE ACTUAL PARAMETERS FOR THIS PLY TABLE ENTRY
        C       AND SETUP FOR DYNAMIC MODIFICATION WITHIN THE NEXT DO LOOP.
        C
0234            SAVLEN=PLYLEN(PLY)
0235            PLYNUM(PLY)=PLYNUM(PLY-1)
0236            PLYLEN(PLY)=PLYLEN(PLY-1)
        C
        C       STEP THROUGH EACH PLY FOR THIS GROUP.
        C
0237            DO 370 NCODE=N1,N2
0238            DIR=-DIR
        C
        C       DYNAMICALLY MODIFY THE CURRENT PLY LENGTH AND NUMBER.
        C
0239            PLYNUM(PLY)=NCODE
0240            PLYLEN(PLY)=PLYLEN(PLY)+YINC
        C
        C       CALCULATE L1,L2 AND L3
        C
0241            L1=PLYLEN(1)
0242            L2=PI*(RM+(NCODE-1)*THICK)
0243            DO 310 I=2,PLY
0244            YSIDE=PLYLEN(I)-PLYLEN(I-1)
0245            ZSIDE=PLYNUM(I)*THICK
0246            RTEMP=YSIDE*YSIDE+ZSIDE*ZSIDE
0247    310     L1=L1+SQRT(RTEMP)
0248            L3=L1
0249            TOTLEN(1)=TOTLEN(1)+L1+L2+L3
        C
0250            BFLAG=.TRUE.
0251            IF(P2MIN.EQ.NCODE) GO TO 400
0252            IF(P2MIN.LE.0 .AND. SHRLEN+0.5.LT.L3) GO TO 400
        C
0253            SHRXXX=L1+L2+L3-SHRLEN
0254            CURLEN=0.0
        C
        C       DO PLY #NCODE SEGMENT 0.
        C
0255            Y=YM+DIR*(PLYLEN(PLY)+1.0)
```

59

```
0256          C=180.0-DIR*90.0
0257          CALL MOVE(,Y,,,C)
0258          Z=BASE+1.0
0259          CALL MOVE(,,Z,,,,NCODE)
0260          Y=YM+DIR*PLYLEN(PLY)
0261          CALL MOVE(,Y,BASE)
0262          CALL MOVE(,,TBASE)
0263          CALL CLAMP(OFF)
     C
     C        SAVE CURRENT Y AND Z CO-ORDINATES FOR THE NEXT PART.
     C
0264          YCUR=Y
0265          ZCUR=TBASE
     C
     C        LAY PLY #NCODE SEGMENT 1.
     C
0266   330    DO 339 I=1,PLY
0267          IPLY=PLY-I
0268          JPLY=PLY-I+1
     C
     C        CALCULATE NEW Y AND Z CO-ORDINATES.
     C
0269          IF(IPLY.EQ.0)  YNEW=YM
0270          IF(IPLY.GT.0)  YNEW=YM+DIR*PLYLEN(IPLY)
0271          IF(IPLY.EQ.0)  ZNEW=TBASE+THICK*PLYNUM(PLY)
0272          IF(IPLY.GT.0)  ZNEW=ZCUR+THICK*(PLYNUM(JPLY)-PLYNUM(IPLY))
     C
     C        CALCULATE RIGHT TRIANGLE AND STUFF.
     C
0273          YSIDE=YNEW-YCUR
0274          ZSIDE=ZNEW-ZCUR
0275          RTEMP=YSIDE*YSIDE+ZSIDE*ZSIDE
0276          RTEMP=SQRT(RTEMP)
     C
     C        SEE IF IT IS TIME TO CUT AND TAKE CARE OF IT IF SO.
     C
0277          IF(CURLEN.GT.SHRXXX .OR. CURLEN+RTEMP.LT.SHRXXX) GO TO 335
0278          FACTOR=(SHRXXX-CURLEN)/RTEMP
0279          Y=YCUR+YSIDE*FACTOR
0280          Z=ZCUR+ZSIDE*FACTOR
0281          CALL MOVE(,Y,Z)
0282          CALL SHEAR
0283   335    CALL MOVE(,YNEW,ZNEW)
0284          YCUR=YNEW
0285          ZCUR=ZNEW
0286          CURLEN=CURLEN+RTEMP
0287   339    CONTINUE
     C
     C        LAY PLY #NCODE SEGMENT 2.
     C
0288   340    RTEMP=PI*(RM+THICK*PLYNUM(PLY))
0289          IF(CURLEN.GT.SHRXXX .OR. CURLEN+RTEMP.LT.SHRXXX) GO TO 345
0290          D=-DIR*90.0*(1.0+DIR)+(180.0*(SHRXXX-CURLEN)/RTEMP)
0291          CALL MOVE(,,,,D)
0292          CALL SHEAR
0293   345    IF(DIR.EQ.1)  D=-.0001
```

60

```
0294        IF(DIR.EQ.-1) D=180.0
0295        IF(DIR.NE.1 .AND. DIR.NE.-1) STOP 12345
0296        CALL MOVE(,,,,D)
0297        CURLEN=CURLEN+RTEMP
       C
       C        LAY PLY #NCODE SEGMENT 3.
       C
0298 350    DO 359 I=1,PLY
0299        IPLY=I-1
0300        JPLY=I
       C
       C        CALCULATE NEW Y AND Z CO-ORDINATES.
       C
0301        YNEW=YM-DIR*PLYLEN(JPLY)
0302        IF(IPLY.EQ.0) ZNEW=ZCUR-THICK
0303        IF(IPLY.GT.0) ZNEW=ZCUR-THICK*(PLYNUM(JPLY)-PLYNUM(IPLY))
       C
       C        CALCULATE RIGHT TRIANGLE AND STUFF.
       C
0304        YSIDE=YNEW-YCUR
0305        ZSIDE=ZNEW-ZCUR
0306        RTEMP=YSIDE*YSIDE+ZSIDE*ZSIDE
0307        RTEMP=SQRT(RTEMP)
       C
       C        SEE IF IT IS TIME TO CUT AND TAKE CARE OF IT IF SO.
       C
0308        IF(CURLEN.GT.SHRXXX .OR. CURLEN+RTEMP.LT.SHRXXX) GO TO 355
0309        FACTOR=(SHRXXX-CURLEN)/RTEMP
0310        Y=YCUR+YSIDE*FACTOR
0311        Z=ZCUR+ZSIDE*FACTOR
0312        CALL MOVE(,Y,Z)
0313        CALL SHEAR
0314 355    CALL MOVE(,YNEW,ZNEW)
0315        YCUR=YNEW
0316        ZCUR=ZNEW
0317        CURLEN=CURLEN+RTEMP
0318 359    CONTINUE
       C
       C        LAY PLY #NCODE SEGMENT 4.
       C
0319 360    CALL CLAMP(ON)
0320        Z=BASE+THICK
0321        CALL MOVE(,,Z)
0322        Y=YM-DIR*(PLYLEN(PLY)+1.0)
0323        Z=Z+1.0
0324        CALL MOVE(,Y,Z)
0325        Z=Z+2.0
0326        CALL MOVE(,,Z)
       C
       C        TERMINATE THE LOOP THAT GOES BETWEEN TABLE ENTRIES.
       C
0327 370    CONTINUE
       C
       C        RESTORE THIS TABLE ENTRY (WHICH SHOULD BE RIGHT BUT JUST IN CASE)
       C        AND FINISH UP THE TABLE SCAN LOOP.
       C
```

61

```
0328            PLYNUM(PLY)=N2
0329            PLYLEN(PLY)=SAVLEN
0330  380       CONTINUE
0331            BFLAG=.FALSE.
          C
          C     FINISH UP.
          C
0332  400       CALL HEAD(OFF)
0333            IF(FFLAG.EQ..TRUE.) CALL MOVE(XFINAL,YFINAL,ZFINAL)
0334            CALL EOT
0335            IF(BFLAG.EQ..FALSE.) GO TO 900
          C
          C     DO PART 2.....
          C
          C     INITIALIZE.....
          C
0336  500       BASE=ZM2+RM
0337            TBASE=BASE-TRAVEL/2.0
0338            CLAMPX=3.5
0339            WINDEL=THICK*(XM2-WINDUP)/(RM+THICK*PLYNUM(PLY))
0340            WINDEL=ABS(WINDEL)
0341            DIR=-1.0
0342            CALL DELETE(3)
          C
          C     DO "PART 2" PREAMBLE.
          C
0343            CALL BOT(3,0)
0344            CALL BUILD('G',1)
0345            CALL BUILD('G',90)
0346            CALL PUNCH
0347            CALL HEAD(ON)
0348            Z=BASE+3.0
0349            CALL MOVE(0.0,0.0,Z,0.0,180.0,0.0)
0350            IF(I2FLAG.EQ..TRUE.) CALL MOVE(X20,Y20,Z20)
0351            IF(I2FLAG.EQ..FALSE. .OR. YM2.NE.Y20) CALL MOVE(,YM2)
0352            CALL CLAMP(ON)
          C
          C     NOTE THAT BFLAG=.TRUE. HERE.....
          C
0353            NPLY=PLY
0354            N1=NCODE
          C
          C     LAY REST OF PART 2 PLIES BY STEPPING THROUGH THE PLY TABLE.
          C
0355            DO 580 PLY=NPLY,PLYMAX
0356            IF(BFLAG.EQ..TRUE.) GO TO 501
0357            N1=PLYNUM(PLY-1)+1
0358            N2=PLYNUM(PLY)
0359            M2=PLY-1
0360            YINC=(PLYLEN(PLY)-PLYLEN(PLY-1))/(N2-(N1-1))
          C
          C     TEMPORARILY SAVE THE ACTUAL PARAMETERS FOR THIS PLY TABLE ENTRY
          C     AND SETUP FOR DYNAMIC MODIFICATION WITHIN THE NEXT DO LOOP.
          C
0361            SAVLEN=PLYLEN(PLY)
```

62

```
0362          PLYNUM(PLY)=PLYNUM(PLY-1)
0363          PLYLEN(PLY)=PLYLEN(PLY-1)
0364  501     CONTINUE
      C
      C       STEP THROUGH EACH PLY FOR THIS GROUP.
      C
0365          DO 570 NCODE=N1,N2
0366          DIR=-DIR
      C
      C       DYNAMICALLY MODIFY THE CURRENT PLY LENGTH AND NUMBER.
      C
0367          IF(BFLAG.EQ..TRUE.) GO TO 502
0368          PLYNUM(PLY)=NCODE
0369          PLYLEN(PLY)=PLYLEN(PLY)+YINC
0370  502     CONTINUE
      C
      C       CALCULATE L1
      C
0371          L1=PLYLEN(1)
0372          L2=PI*(RM+(NCODE-1)*THICK)
0373          DO 510 I=2,PLY
0374          XSIDE=PLYLEN(I)-PLYLEN(I-1)
0375          ZSIDE=PLYNUM(I)*THICK
0376          RTEMP=XSIDE*XSIDE+ZSIDE*ZSIDE
0377  510     L1=L1+SQRT(RTEMP)
0378          TOTLEN(2)=TOTLEN(2)+L1+L2+L3
0379          SHRXX=L1-SHRLEN
0380          IF(SHRXX.LT.0.0) CALL ERR(11,0)
0381          IF(SHRXX.EQ.0.0) CALL ERR(12,1)
0382          IF(CLAMPX.LT.0.0) CALL ERR(13,0)
0383          IF(CLAMPX.EQ.0.0) CALL ERR(14,1)
0384          CURLEN=0.0
      C
      C       LAY THIS PLY.
      C
0385          X=XM2-PLYLEN(PLY)-1.0
0386          CALL MOVE(X)
0387          Z=BASE+1.0
0388          CALL MOVE(,,Z,,,,NCODE)
0389          X=XM2-PLYLEN(PLY)
0390          CALL MOVE(X,,BASE)
0391          CALL MOVE(,,TBASE)
0392          CALL CLAMP(OFF)
0393          ZCUR=TBASE
0394  530     DO 539 I=1,PLY
0395          IPLY=PLY-I
0396          JPLY=PLY-I+1
      C
      C       CALCULATE NEW X AND, Z CO-ORDINATES.
      C
0397          IF(IPLY.EQ.0) XNEW=XM2
0398          IF(IPLY.GT.0) XNEW=XM2-PLYLEN(IPLY)
0399          IF(IPLY.EQ.0) ZNEW=TBASE+THICK*PLYNUM(PLY)
0400          IF(IPLY.GT.0) ZNEW=ZCUR+THICK*(PLYNUM(JPLY)-PLYNUM(IPLY))
0401          CALL MOVE(XNEW,,ZNEW)
```

63

```
0402        ZCUR=ZNEW
0403   539  CONTINUE
       C
0404        CALL MOVE(PULOUT)
0405        CALL MOVE(BACKUP)
0406        D=90.0*(DIR+1.0)
0407        CALL MOVE(,,,359.99,D)
0408        CALL MOVE(WINDUP)
0409        WINDUP=WINDUP-WINDEL
0410        CALL SLIT(ON)
0411        CALL DELAY(5.0)
0412        CALL CLAMP(ON)
0413        CALL MOVE(XM2)
0414        XCUR=XM2
       C
0415   550  DO 559 I=1,PLY
0416        IPLY=I-1
0417        JPLY=I
       C
       C         CALCULATE NEW X AND Z CO-ORDINATES.
       C
0418        XNEW=XM2-PLYLEN(JPLY)
0419        IF(IPLY.EQ.0) ZNEW=ZCUR-THICK
0420        IF(IPLY.GT.0) ZNEW=ZCUR-THICK*(PLYNUM(JPLY)-PLYNUM(IPLY))
       C
       C         FIGURE RIGHT TRIANGLE AND STUFF.
       C
0421        XSIDE=XNEW-XCUR
0422        ZSIDE=ZNEW-ZCUR
0423        RTEMP=XSIDE*XSIDE+ZSIDE*ZSIDE
0424        RTEMP=SQRT(RTEMP)
       C
       C         SET CONTROL VARIABLES FOR THE NEXT PART.
       C
0425        CFLAG=.FALSE.
0426        SFLAG=.FALSE.
0427        CBSFLG=.FALSE.
0428        IF(CLAMPX.GE.CURLEN .AND. CLAMPX.LT.CURLEN+RTEMP) CFLAG=.TRUE.
0429        IF(SHRXXX.GE.CURLEN .AND. SHRXXX.LT.CURLEN+RTEMP) SFLAG=.TRUE.
0430        IF(CLAMPX.LT.SHRXXX) CBSFLG=.TRUE.
       C
       C         TAKE CARE OF CLAMP AND SHEAR HERE.
       C
0431        IF(CFLAG.EQ..FALSE..OR. CBSFLG.EQ.FALSE.) GO TO 551
0432        FACTOR=(CLAMPX-CURLEN)/RTEMP
0433        X=XCUR+XSIDE*FACTOR
0434        Z=ZCUR+ZSIDE*FACTOR
0435        CALL MOVE(X,,Z)
0436        CALL SLIT(OFF)
0437        CALL CLAMP(OFF)
0438        XSIDE=X-XCUR
0439        ZSIDE=Z-ZCUR
0440        RTEMP=XSIDE*XSIDE+ZSIDE*ZSIDE
0441        RTEMP=SQRT(RTEMP)
0442        CURLEN=CURLEN+RTEMP
0443        XCUR=X
```

64

```
0444        ZCUR=Z
        C
0445    551  IF(SFLAG.EQ..FALSE.) GO TO 552
0446         FACTOR=(SHRXX-CURLEN)/RTEMP
0447         X=XCUR+XSIDE*FACTOR
0448         Z=ZCUR+ZSIDE*FACTOR
0449         CALL MOVE(X,.Z)
0450         CALL SHEAR
0451         XSIDE=X-XCUR
0452         ZSIDE=Z-ZCUR
0453         RTEMP=XSIDE*XSIDE+ZSIDE*ZSIDE
0454         RTEMP=SQRT(RTEMP)
0455         CURLEN=CURLEN+RTEMP
0456         XCUR=X
0457         ZCUR=Z
        C
0458    552  IF(CFLAG.EQ..FALSE..OR. CBSFLG.EQ..TRUE.) GO TO 557
0459         FACTOR=(CLAMPX-CURLEN)/RTEMP
0460         X=XCUR+XSIDE*FACTOR
0461         Z=ZCUR+ZSIDE*FACTOR
0462         CALL MOVE(X,.Z)
0463         CALL SLIT(OFF)
0464         CALL CLAMP(OFF)
0465         XSIDE=X-XCUR
0466         ZSIDE=Z-ZCUR
0467         RTEMP=XSIDE*XSIDE+ZSIDE*ZSIDE
0468         RTEMP=SQRT(RTEMP)
0469         CURLEN=CURLEN+RTEMP
0470         XCUR=X
0471         ZCUR=Z
        C
        C       FINISH UP THIS SEGMENT.
        C
0472    557  CALL MOVE(XNEW,.ZNEW)
        C
        C       CALCULATE RIGHT TRIANGLE AND STUFF.
        C
0473    558  XSIDE=XNEW-XCUR
0474         ZSIDE=ZNEW-ZCUR
0475         RTEMP=XSIDE*XSIDE+ZSIDE*ZSIDE
0476         RTEMP=SQRT(RTEMP)
0477         CURLEN=CURLEN+RTEMP
0478         XCUR=XNEW
0479         ZCUR=ZNEW
0480    559  CONTINUE
        C
        C       FINISH UP THIS PLY....
        C
0481         CALL CLAMP(ON)
0482         Z=BASE+THICK
0483         CALL MOVE(.,Z)
0484         X=XNEW-1.0
0485         Z=Z+1.0
0486         CALL MOVE(X,.Z)
0487         Z=Z+2.0
0488         CALL MOVE(.,Z)
```

65

```
0489        CALL MOVE(.,.,180.0)
       C
       C        TERMINATE THE LOOP THAT GOES BETWEEN TABLE ENTRIES.
0490        BFLAG=.FALSE.
0491  570  CONTINUE
       C
       C        RESTORE THIS TABLE ENTRY (WHICH SHOULD BE RIGHT BUT JUST IN CASE...),
       C        AND FINISH UP THE TABLE SCAN LOOP.
0492        PLYNUM(PLY)=N2
0493        PLYLEN(PLY)=SAVLEN
0494  580  CONTINUE
       C
       C        FINISH UP.
       C
0495  600  CALL HEAD(OFF)
0496        IF(F2FLAG.EQ..TRUE.) CALL MOVE(X2FINL,Y2FINL,Z2FINL)
0497        CALL EOT
       C
       C
       C
0498  900  TOTLEN(1)=TOTLEN(1)/12.0
0499        TOTLEN(2)=TOTLEN(2)/12.0
0500        WRITE(6,901)TAB,TOTLEN(1),TAB,TOTLEN(2)
0501  901  FORMAT(1X,A1,'TOTAL FIBERGLASS TAPE LENGTH:  PART 1 =',F7.1,' FT'/
           +       1X,A1,'                                  PART 2 =',F7.1,' FT')
0502        CALL EXIT
0503        E N D
```

```
ROUTINES CALLED:
CMPB  , DELETE , ASSIGN , FILLB  , DATE   , TIME   , MOVB
ERR   , BOT    , BUILD  , PUNCH  , MOVE   , HEAD   , CLAMP
SHEAR , SQRT   , EOT    , ABS    , SLIT   , DELAY  , EXIT

OPTIONS =/ON,/OP:1

BLOCK     LENGTH
MAIN.     6094    (027634)*

**COMPILER ----- CORE**
        PHASE      USED   FREE
DECLARATIVES   00622  14434
EXECUTABLES    02223  12833
ASSEMBLY       03167  16529
```

2.4   PTDUMP - Paper Tape Dump

Purpose: To punch ATLS control tape data stored in the system data storage into paper tape.

Calling Sequence and Arguments: N.A.

Called By: N.A.

Subroutines Called:

	ASSIGN	DATE
	MRL	TIME
	PCHAR	CHAR
	FILLB	PCLOSE
	MOVB	EXIT

Diagnostics: None.

Detailed Description: Program PTDUMP first interrogates the operator and reads an optional text string to be punched as man-readable leader. This string is punched into the paper tape along with the current data and time. Following this, twenty inches of blank tape are punched followed by ASCII carriage return and line feed characters. The control tape file is then scanned character by character and punched into the output tape in ASCII.

```
FORTRAN V06.13            10:12:08   03-OCT-76   PAGE   1

      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C                                                                  C
      C     PROGRAM "PTDUMP"....                                         C
      C                                                                  C
      C     ROUTINE TO DUMP ATLAS CONTROL TAPES TO PAPER TAPE.           C
      C                                                                  C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
0001  C     IMPLICIT INTEGER (A-Z)
      C
0002        BYTE LEADER(400),LINE(80)
0003        EQUIVALENCE (LINE(1),LEADER(401))
0004        LOGICAL SCANSW,EIAFLG
0005        COMMON/CHRCOM/SCANSW,EIAFLG
      C
0006        SCANSW=.TRUE.
0007        CALL ASSIGN(15,'KB:',0)
0008        CALL ASSIGN(16,'KB:',0)
      C
0009        WRITE(16,2)
0010  1     FORMAT(' +ENTER LEADER STRING'/)
0011  2     READ(15,3)LINE,COUNT
0012  3     FORMAT(80A1,Q)
0013        IF(COUNT.LE.0) GO TO 6
0014        CALL MRL(LINE,,LEADER,,COUNT)
0015        COUNT=6*COUNT
0016        DO 4 I=1,COUNT
0017  4     CALL PCHAR(LEADER(I))
0018  5     DO 5 I=32
0019        CALL PCHAR(0)
0020  5     CALL FILLB(' ',LINE,,80)
0021  6     CALL MOVB('<<<',,LINE(11),,3)
0022        CALL DATE(LINE(16))
0023        CALL TIME(LINE(28))
0024        CALL MOVB('<<<',,LINE(40),,3)
0025        CALL MRL(LINE,,LEADER,,80)
0026        DO 7 I=1,400
0027  7     CALL PCHAR(LEADER(I))
0028        COUNT=0
      C     WRITE A REWIND STOP CODE.
0029        CALL PCHAR(153)
      C
0030  10    C=CHAR()
0031        IF(C)90,11,13
0032  11    COUNT=COUNT+1
0033        C=13
0034        CALL EPARTY(C,,1)
0035        CALL PCHAR(C)
0036        C=10
0037  13    CALL EPARTY(C,,1)
0038        CALL PCHAR(C)
0039        GO TO 10
      C
0040  90    CALL PCLOSE
```

68

```
FORTRAN V06.13                    10:12:08    03-OCT-76    PAGE    2

0041        WRITE(16,91)COUNT
0042    91  FORMAT('+',I5,' LINES PROCESSED'/)
0043        CALL EXIT
0044        E N D


    ROUTINES CALLED:
    ASSIGN, MRL , PCHAR , FILLB , MOVB  , DATE  , TIME
    CHAR  , EPARTY, PCLOSE, EXIT

    OPTIONS =/ON,/OP:1

    BLOCK       LENGTH
    MAIN.  683    (002526)*
    CHRCOM  2     (000004)

    **COMPILER ----- CORE**
        PHASE     USED  FREE
    DECLARATIVES 00622 14434
    EXECUTABLES  01043 14013
    ASSEMBLY     01340 18356
```

69

2.5 PTLOAD - Paper Tape Loader

Purpose: To read ATLS control tapes and enter them into the system data storage.

Calling Sequence and Arguments: N.A.

Called By: N.A.

Subroutines Called: ASSIGN
                          CHAR
                          EXIT

Diagnostics: None.

Detailed Description: Program PTLOAD first interrogates the operator and reads a file name for the control tape that is to be stored in the system data storage. Subroutine CHAR is successively called to get characters from the input tape and to assemble them into a line. When an end-of-block code is encountered, the currently accumulated line is written to the system data storage. This process continues until the physical end of the input tape is encountered and the program terminates.

```
FORTRAN V06.13                10:11:47   03-OCT-76   PAGE   1

      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C                                                                 C
      C     PROGRAM "PTLOAD" PRODUCES AN ASCII FILE FROM AN ATLAS CONTROL C
      C     TAPE.  THIS TAPE MAY BE EITHER ASCII OR EIA CODES.  THE OUTPUT C
      C     FILE WILL CONTAIN CR/LF AS A LINE TERMINATOR INSTEAD OF JUST  C
      C     A CR                                                         C
      C                                                                 C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C
0001        IMPLICIT INTEGER (A-Z)
0002        INTEGER OUTBUF(132),INBUF(20)
0003        LOGICAL SCANSW,EIAFLG
0004        COMMON/CHRCOM/SCANSW,EIAFLG
      C
      C     DO SOME INITIALIZATION....
      C
0005        CALL ASSIGN(15,'KB:',0)
0006        CALL ASSIGN(16,'KB:',0)
0007        WRITE(16,1)
0008  1     FORMAT('$ENTER OUTPUT FILENAME....')
0009        READ(15,2)INBUF
0010  2     FORMAT(20A2)
0011        CALL ASSIGN(6,INBUF,40)
0012        WRITE(6,3)
0013  3     FORMAT(1X)
0014        SCANSW=.TRUE.
0015        NUM=0
      C
      C     GET ONE CHARACTER AT A TIME UNTIL YOU GET THE WHOLE LINE.
      C
0016  10    I=0
0017  30    C=CHAR()
0018        IF(C)98,50,40
0019  40    I=I+1
0020        OUTBUF(I)=C
0021        IF(I.GE.132) I=131
0022        GO TO 30
0023  50    IF(I.EQ.0) GO TO 30
0024        WRITE(6,51)(OUTBUF(J),J=1,I)
0025  51    FORMAT(132A1)
0026        NUM=NUM+1
0027        GO TO 10
      C
0028  98    WRITE(16,99)NUM
0029  99    FORMAT(I7,' RECORDS COPIED')
0030        CALL EXIT
0031        E N D


      ROUTINES CALLED:
      ASSIGN, CHAR , EXIT

      OPTIONS =/ON,/OP:1

      BLOCK       LENGTH
      MAIN.     442   (001564)*
      CHRCOM    2     (000004)
```

71

3.   SUBROUTINES

3.1 ANSWER

Purpose: Subroutine to retrieve keyboard input from the Tektronix
graphic display unit.

Calling Sequence and Arguments:

        CALL ANSWER(ANSBUF)

        where:

        ANSBUF is a 24 byte array where the response is
        returned as a string of ASCII characters.

Called by: RESET

Subroutines Called: ANMODE   TINPUT
                       CLRB   ANCHO
                       BELL   NEWLIN

Diagnostics: None

Detailed Description: Upon entry, the 24 byte argument buffer is
cleared to all zeros. Subroutine TINPUT is then called iteratively and
each character is stored in sequential bytes of the argument array. As
each character is received, it is also echoed back to the terminal. When
a carriage return character is encountered, subroutine NEWLIN is called to
position the cursor to the beginning of the next line and the subroutine re-
turns.

```
FORTRAN V06.13              10:18:58    03-OCT-76    PAGE   1

0001        SUBROUTINE ANSWER(ANSBUF)
       C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C                                                          C
       C       SUBROUTINE TO RECEIVE A LINE FROM THE TUBE.        C
       C                                                          C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C
0002        IMPLICIT INTEGER (A-Z)
0003        BYTE ANSBUF(24)
0004        DATA CR,CNTLU,RUBOUT,LOLIM,HILIM/13,21,127,32,96/
0005        CALL ANMODE
0006        CALL CLRB(ANSBUF,.24)
0007        CALL BELL
0008     1  I=1
0009     2  CALL TINPUT(CHAR)
0010        CHAR=CHAR.AND.127
0011        IF(CHAR.LT.LOLIM .OR. CHAR.GT.HILIM) GO TO 3
0012        IF(I.GE.23) GO TO 2
0013        ANSBUF(I)=CHAR
0014        CALL ANCHO(CHAR)
0015        I=I+1
0016        GO TO 2
0017     3  IF(CHAR.EQ.CR) GO TO 9
0018        IF(CHAR.NE.CNTLU) GO TO 4
0019        CALL ANCHO('^')
0020        CALL ANCHO('U')
0021        CALL NEWLIN
0022        GO TO 1
0023     4  IF(CHAR.NE.RUBOUT) GO TO 5
0024        IF(I.LE.1) GO TO 1
0025        CALL ANCHO('\')
0026        I=I-1
0027        GO TO 2
0028     5  CALL BELL
0029        GO TO 2
0030     9  CALL NEWLIN
0031        RETURN
0032        E N D


ROUTINES CALLED:
ANMODE, CLRB , BELL , TINPUT, ANCHO , NEWLIN

OPTIONS =/ON,/OP:1

BLOCK        LENGTH
ANSWER   265    (001022)*

**COMPILER ----- CORE**
     PHASE    USED  FREE
DECLARATIVES  00622 14434
EXECUTABLES   00863 14193
ASSEMBLY      01103 18593
```

73

3.2 BOT

Purpose: Subroutine to initialize a control tape file.

Calling Sequence and Arguments:

CALL BOT(NUNIT,STRING)

where:

NUNIT is an integer FORTRAN logical unit number.

STRING is byte array containing a string of up to
80 ASCII characters terminated by a character of
binary zeros.

Called by: PLYGEN

Subroutines Called: None

Diagnostics: None

Detailed Description: This subroutine first moves the character
string into a local buffer and calculates its length (not including the
null byte). If this length is zero, the subroutine writes a single end-
of-block (carriage return and line feed) and returns. If the string length
is greater than zero, that string is written to the control tape file and
the subroutine returns. In either of the above cases, the control tape file
is on the FORTRAN logical unit number specified by the first argument.

```
FORTRAN V06.13                    10:21:11    03-OCT-76   PAGE   1

0001      SUBROUTINE BOT(NUNIT,STRING)
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C                                                                C
      C       SUBROUTINE TO PUNCH "MAN-READABLE LEADER" AND OTHERWISE  C
      C       INITIALIZE THE TAPE.                                     C
      C                                                                C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C
0002      INTEGER TPTR,MODE,UNIT
0003      BYTE TAPE(80)
0004      BYTE STRING(80),LCLSTR(80)
0005      COMMON/TAPCOM/TPTR,TAPE,MODE,UNIT
      C
0006      UNIT=NUNIT
0007      TPTR=1
      C
0008      DO 10 J=1,80
0009      IF(STRING(J).EQ.0) GO TO 20
0010  10  LCLSTR(J)=STRING(J)
0011      J=81
0012  20  J=J-1
0013      IF(J.GT.0) GO TO 30
0014      WRITE(UNIT,100)
0015  100 FORMAT(/)
0016      RETURN
      C
0017  30  WRITE(UNIT,101)(LCLSTR(K),K=1,J)
0018  101 FORMAT(80A1)
0019      RETURN
0020      E N D

OPTIONS =/ON,/OP:1

BLOCK       LENGTH
BOT    190  (000574)*
TAPCOM  43  (000126)

**COMPILER ----- CORE**
    PHASE    USED   FREE
DECLARATIVES 00622 14434
EXECUTABLES  00795 14261
ASSEMBLY     01056 18640
```

75

3.3 BUILD

Purpose: Subroutine to assemble ATLS control codes into a block to be written to the control tape file.

Calling Sequence and Arguments:

CALL BUILD(C,V)

where:

C - an ASCII character indicating the control code type
V - a real number with the value of that code.

Called By: PLYGEN et. al.

Subroutines Called: FILLB
                           MOVB

Diagnostics: STOP 177777 - Invalid C character
                  STOP 177776 - Buffer overflow.

Detailed Description: This subroutine starts by searching an internal table of valid control code type characters for a match on the first argument. When a match is found, control is transferred to the appropriate routine to service this control code. Each service routine scales the real number by the appropriate factor of ten and formats it into a string of ASCII characters using the ENCODE facility of the FORTRAN system. The characters are then moved into the next sequentially available bytes of the output buffer and the routine returns to the caller.

```
0001        SUBROUTINE BUILD(C,V)
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C      SUBROUTINE TO BUILD CONTROL CODES INTO A TAPE BUFFER.
      C      THE TAPE MUST BE SUBSEQUENTLY BE PUNCHED BY "CALL PUNCH"
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C
0002        BYTE C,CTBL(14),WORK(10),BLANK
0003        BYTE TAPE(80)
0004        REAL V,RV
0005        INTEGER TPTR,MODE,UNIT,IV
0006        EQUIVALENCE(RV,IV)
0007        COMMON/TAPCOM/TPTR,TAPE,MODE,UNIT
0008        DATA CTBL/1HN,1HG,1HM,1HS,1HX,1HY,1HZ,1HA,1HC,1HD,1HI,1HJ,1HK,1HF/
0009        DATA BLANK/' '/
      C
      C      DO SOME INITIAL CHECKS.
      C
0010        IF(TPTR.GT.72) STOP 177776
0011        IF(TPTR.GT.1) GO TO 100
0012        TPTR=1
0013        CALL FILLB(' ',TAPE,,80)
0014        MODE=-1
      C
      C      PROCESS THIS CALL.
      C
0015  100   CALL FILLB(' ',WORK,,10)
0016        TAPE(TPTR)=C
0017        TPTR=TPTR+1
0018        RV=V
0019        DO 110 I=1,14
0020        IF(CTBL(I).EQ.C) GO TO 120
0021  110   CONTINUE
0022        STOP 177777
0023  120   GO TO (1,2,3,3,5,5,5,9,5,5,5,5,5,14),I
      C
      C      N CODE COMES HERE.
      C
0024  1     ENCODE(4,901,WORK)IV
0025  901   FORMAT(I4)
0026        CALL MOVB(WORK,,TAPE(TPTR),,4)
0027        ISIZE=4
0028        GO TO 990
      C
      C      G CODE COMES HERE (AND FALLS THROUGH TO THE NEXT.)
      C
0029  2     MODE=IV
      C
      C      G, M, AND S CODES COME HERE.
      C
0030  3     ENCODE(2,903,WORK)IV
0031  903   FORMAT(I2)
```

```
FORTRAN V06.13                    10:21:37     03-OCT-76    PAGE    2

0032          CALL MOVB(WORK,,TAPE(TPTR),,2)
0033          ISIZE=2
0034          GO TO 990
      C
      C       X, Y, Z, A, D, I, J, AND K CODES COME HERE.
      C
0035   5      RVV=RV*1000.0
0036          ENCODE(9,905,WORK) RVV
0037   905    FORMAT(F9.0)
0038          CALL MOVB(WORK,,TAPE(TPTR),,8)
0039          ISIZE=8
0040          GO TO 990
      C
      C       C CODE COMES HERE.
      C
0041   9      RVV=RV*100.0
0042          ENCODE(9,909,WORK) RVV
0043   909    FORMAT(F9.0)
0044          CALL MOVB(WORK,,TAPE(TPTR),,8)
0045          ISIZE=8
0046          GO TO 990
      C
      C       F CODE COMES HERE.  NOTE THAT F CODE FORMAT IS MODE DEPENDENT.....
      C
0047   14     IF(MODE.EQ.04) GO TO 141
0048          RVV=RV*1000.0
0049          ENCODE(9,914,WORK) RVV
0050   914    FORMAT(F9.0)
0051          CALL MOVB(WORK,,TAPE(TPTR),,8)
0052          ISIZE=8
0053          GO TO 990
0054   141    RVV=RV*100.0
0055          ENCODE(6,9141,WORK) RVV
0056   9141   FORMAT(F6.0)
0057          CALL MOVB(WORK,,TAPE(TPTR),,5)
0058          ISIZE=5
      C
      C       PACK THE CURRENT VALUE OF THE WORK AREA INTO THE TAPE BUFFER.
      C
0059   990    DO 991 I=1,ISIZE
0060          IF(WORK(I).EQ.BLANK) GO TO 991
0061          TAPE(TPTR)=WORK(I)
0062          TPTR=TPTR+1
0063   991    CONTINUE
0064          E N D

ROUTINES CALLED:
FILLB , MOVB

OPTIONS =/ON,/OP:1

BLOCK      LENGTH
BUILD      587    (002226)*
TAPCOM     43     (000126)
```

78

3.4 CHAR (Assembly Language)

Purpose: Function subroutine to read a paper tape and pass the characters back to the calling routine.

Calling Sequence and Arguments:

I = CHAR( )

where the returned value indicates:

ASCII character if I.GT.0
End-of-block encountered if I.EQ.0
Physical end-of-tape encountered if I.LT.0

Called By: Many

Subroutines Called: EIA2A

Diagnostics: None

Detailed Description: All five main programs call this subroutine either directly or indirectly. This routine is set up so that it can read either paper tape or system data storage with the codes in either EIA or ASCII.

Upon entry, the subroutine checks to see if it has been entered previously within this program execution. If not, it executes a block of one-time code to perform the following initialization functions:

• Set a flag so the rest of the initialization is not executed again.

• INIT and OPEN a dataset with the logical name IN.

• Read the first block of data and initialize the local buffer pointer.

- Scan for the first end-of-block character and determine whether the tape code is EIA or ASCII.

- Set the code type flag based on the first EOB code.

The remainder of the subroutine is executed for every call. ASCII characters are taken one at a time and returned to the calling program. When the input buffer is exhausted, a new buffer is read and converted from EIA to ASCII if necessary. Before returning, the current character is matched with the entries of a table of characters to ignore. If a match is found, the routine loops back and gets a new character. End-of-block characters cause a binary zero to be returned and if an end-of-file condition is encountered on the input dataset, a binary-1 is returned.

CHAR - GET EIA CHAR FOR AVSCOM.   MACRO V06-03 03-OCT-76 10:22 PAGE 1

```
   1                                      .NLIST  TTM
   2                                      .NLIST  SYM
   3                                      .TITLE  CHAR - GET EIA CHAR FOR AVSCOM.
   4                                      .DSABL  GBL
   5                                      .ENABL  AMA
   6                                      ;
   7                                      .MCALL  .INIT,.OPEN,.READ,.WAIT,.CLOSE,.RLSE
   8                                      .GLOBL  CHAR
   9  000000  005737  000000'   CHAR:     TST     SCANSW                   ; IS THE INITIAL SCAN ON?
  10  000004  001465                      BEQ     10$                      ; NO.
  11  000006  005037  000002'             CLR     EIAFLG                   ; INITIALLY SET EIA=.FALSE.
  12  000012                              .INIT   #LNKBLK                  ; INITIALIZE THE LINK BLOCK.
  13  000020                              .OPEN   #LNKBLK,#FILBLK          ; OPEN THE FILE.
  14  000032  106337  000377'   1$:       ASLB    BUFHDR+3                 ; WAS THAT EOT?
  15  000036  100460                      BMI     6$                       ; YES.
  16  000040                              .READ   #LNKBLK,#BUFHDR          ; READ A BLOCK.
  17  000052                              .WAIT   #LNKBLK                  ; *
  18  000060  012737  000502'             MOV     #BUFHDR+6,BUFPTR         ; GET A POINTER.
  19  000066  005337  000400'   2$:       DEC     BUFHDR+4                 ; DONE?
  20  000072  100757                      BMI     1$                       ; YES. GO GET ANOTHER.
  21  000074  122777  000200              CMPB    #200,@BUFPTR             ; IS THIS AN EIA E-O-B?
  22  000102  001413                      BEQ     3$                       ; YES.
  23  000104  122777  000015              CMPB    #15,@BUFPTR              ; IS THIS AN ASCII E-O-B (CARRIAGE RETURN)?
  24  000112  001420                      BEQ     4$                       ; YES.
  25  000114  122777  000215              CMPB    #215,@BUFPTR             ; IS THIS AN ASCII E-O-B?
  26  000122  001414                      BEQ     4$                       ; YES.
  27  000124  005237  000502'             INC     BUFPTR                   ; BUMP THE POINTER.
  28  000130  000756                      BR      2$                       ; KEEP GOING.
  29  000132  012737  177777   3$:        MOV     #-1,EIAFLG               ; SET EIA FLAG=.TRUE..
  30                  000002'             .GLOBL  EIA2A                    ; *
  31  000140  004537  000000G             JSR     R5,EIA2A                 ; CONVERT THE BUFFER.
  32  000144  000403                      BR      .+10                     ; *
  33  000146  000402'  177777   4$:       .WORD   BUFHDR+6,-1,BUFHDR       ; *
  34  000154  005037  000000'             CLR     SCANSW                   ; SET SCANSW .FALSE.
  35  000160  005237  000502'  10$:       INC     BUFPTR                   ; BUMP THE POINTER.
  36  000164  005337  000400'             DEC     BUFHDR+4                 ; TIME FOR ANOTHER READ?
  37  000170  100042                      BPL     11$                      ; NO.
  38  000172  106337  000377'             ASLB    BUFHDR+3                 ; TEST THE STATUS BYTE.
  39  000176  100013                      BPL     13$                      ; OK.
  40  000200                              .CLOSE  #LNKBLK                  ; CLOSE THE FILE.
  41  000206                              .RLSE   #LNKBLK                  ; *
  42  000214  105037  000377'  6$:        CLRB    BUFHDR+3                 ; RESET STATUS FOR NEXT TIME.
  43  000220  012700  177777              MOV     #-1,R0                   ; RETURN A NEGATIVE NUMBER.
  44  000224  000205                      RTS     R5                       ; RETURN TO FORTRAN.
  45  000226                              .READ   #LNKBLK,#BUFHDR          ; READ A BLOCK.
  46  000240                              .WAIT   #LNKBLK                  ; *
  47  000246  005737  000002'  13$:       TST     EIAFLG                   ; IS IT EIA CODE?
  48  000252  001406                      BEQ     12$                      ; NO.
  49  000254  004537  000000G             JSR     R5,EIA2A                 ; CONVERT.
  50  000260  000403                      BR      .+10                     ; *
  51  000262  000402'  177777             .WORD   BUFHDR+6,-1,BUFHDR       ; *
  52  000270  012737  000401'  12$:       MOV     #BUFHDR+5,BUFPTR         ; RESET THE DATA POINTER.
  53  000276  012700  020000   11$:       MOV     #^177400,R0              ; GET HIGH ORDER BLANK.
  54  000302  157700  000174              BISB    @BUFPTR,R0               ; GET THIS CHAR.
  55  000306  042700  000200              BIC     #200,R0                  ; STRIP PARITY.
  56  000312  122700  000015              CMPB    #15,R0                   ; IS THIS THE CARRIAGE RETURN?
  57  000316  001002                      BNE     15$                      ; NO.
```

```
CHAR - GET EIA CHAR FOR AVSCOM.  MACRO V06-03  03-OCT-76  10:22  PAGE 1-1

58  000320  005000                    CLR     R0                  ; RETURN A ZERO.
59  000322  000205                    RTS     R5                  ; RETURN TO FORTRAN.
60  000324  012701  000504'   15$:    MOV     #IGNORE,R1          ; GET IGNORE TABLE ADDRESS.
61  000330  012702  000007            MOV     #IGEND-IGNORE,R2    ; GET IGNORE TABLE SIZE.
62  000334  120021            14$:    CMPB    R0,(R1)+            ; IS THIS A CHARACTER TO BE STRIPPED?
63  000336  001710                    BEQ     10$                 ; YES.
64  000340  077203                    SOB     R2,14$              ; CHECK ALL.
65  000342  000205                    RTS     R5                  ; RETURN TO FORTRAN.
66
67                            ;
68  000346'           LNKBLK = .+2                                ; LINK BLOCK.
69  000344  000000  000000            .WORD   0,0
70  000350  035160                    .RAD50  /IN/
71  000352  001     000               .BYTE   1,0
72  000354  015270                    .RAD50  /DK/
73  000362'           FILBLK = .+4                                ; FILE BLOCK.
74  000356  000000  000004            .WORD   0,4
75  000362  004554  004470            .RAD50  /ATLAS /
76  000366  014474                    .RAD50  /DAT/
77  000370  000000                    .WORD   0,0
78  000374'           BUFHDR = .+4                                ; BUFFER HEADER.
79  000374  000100  000003            .WORD   64.,3,0             ; DATA BUFFER.
80  000502            BUFPTR: .BLKB   64.                         ; BUFFER POINTER.
81  000502            IGNORE: .BLKW   1                           ; TABLE OF CHARACTERS TO BE IGNORED...
82  000504'                   .BYTE   177                         ; DELETE.
83  000504  177               .BYTE   0                           ; NULL.
84  000505  000               .BYTE   040                         ; BLANK.
85  000506  040               .BYTE   011                         ; HORIZONTAL TAB.
86  000507  011               .BYTE   010                         ; BACK SPACE.
87  000510  010               .BYTE   004                         ; E-O-T (REWIND STOP).
88  000511  004               .BYTE   012                         ; LF (FOR SPECIAL ASCII TAPES ONLY).
89  000512  012       IGEND = .
90  000513'                   .EVEN
91
92                    ;
93  000000G           SCANSW: .CSECT  CHRCOM
94  000000  177777    SCANSW: .WORD   -1
95  000002  177777    EIAFLG: .WORD   -1
96                    ;
97  000001'                   .END

ERRORS DETECTED:  0
FREE CORE:  15041. WORDS
,DK1:<CHAR
```

3.5 CLAMP

Purpose: A convenient routine that generates a single block with appropriate "M-codes" to turn the tape clamp on and off.

Calling Sequence and Arguments:

        CALL CLAMP(L)

        where:

        L is a logical variable.

        .TRUE. generates a clamp on code.

        .FALSE. generates a clamp off code.

Called By: PLYGEN

Subroutines Called: BUILD
                      PUNCH

Diagnostics: None

Detailed Description: PUNCH is called to close out the currently filled buffer. If the argument is .TRUE. then BUILD is called to generate a M-15 code. If the argument is .FALSE. then BUILD is called to generate a M-14 code.

82

```
FORTRAN V06.13          10:20:27    03-OCT-76    PAGE    1

0001          SUBROUTINE CLAMP(L)
       C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C
       C      SUBROUTINE TO TURN THE CLAMP ON OR OFF.....             C
       C      ARGUMENTS:                                             C
       C              L - .TRUE. -- TURNS CLAMP ON                   C
       C                  -.FLASE. -- TURNS CLAMP OFF                C
       C                                                             C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C
0002          LOGICAL L,OFF,ON
0003          DATA OFF,ON/.FALSE...TRUE./
       C
0004          CALL PUNCH
0005          IF(L.EQ.OFF) CALL BUILD('M',74)
0006          IF(L.EQ.ON ) CALL BUILD('M',75)
0007          IF(L.EQ.OFF) CALL DELAY(0.5)
0008          RETURN
0009          E N D

       ROUTINES CALLED:
       PUNCH , BUILD , DELAY

       OPTIONS =/ON,/OP:1

       BLOCK     LENGTH
       CLAMP     85    (000252)*

       **COMPILER ----- CORE**
           PHASE     USED   FREE
       DECLARATIVES  00622  14434
       EXECUTABLES   00783  14273
       ASSEMBLY      00931  18765
```

83

3.6 DELAY

Purpose: A convenient routine that generates a single block with appropriate "G" and "F" codes for a specified time delay.

Calling Sequence and Arguments:

CALL DELAY(T)

where:

T is a real variable containing the time delay in seconds.

Called By: PLYGEN

Subroutines Called: PUNCH
BUILD

Diagnostics: None

Detailed Description: PUNCH is called to flush the current block. BUILD is called to generate a GO4 code and called again to generate the appropriate F-code. PUNCH is called again to write out the buffer.

```
FORTRAN V06.13              10:20:16   03-OCT-76  PAGE    1

0001        SUBROUTINE DELAY(T)
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C                                                         C
      C        SUBROUTINE TO PUNCH A TIME DELAY.                C
      C                                                         C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
0002        REAL T
0003        CALL PUNCH
0004        CALL BUILD('G',04)
0005        CALL BUILD('F',T)
0006        CALL PUNCH
0007        RETURN
0008        E N D

      ROUTINES CALLED:
      PUNCH , BUILD

      OPTIONS =/ON,/OP:1

      BLOCK    LENGTH
      DELAY    50   (000144)*

      **COMPILER ----- CORE**
           PHASE       USED   FREE
      DECLARATIVES   00622  14434
      EXECUTABLES    00702  14354
      ASSEMBLY       00871  18825
```

85

3.7 <u>EOT</u>

<u>Purpose</u>: Subroutine to close out a control tape file.

<u>Calling Sequence and Arguments</u>:

     CALL EOT

<u>Called By</u>: PLYGEN

<u>Subroutines CALLED</u>: PUNCH
         BUILD

<u>Diagnostics</u>: None

<u>Detailed Description</u>: Subroutine PUNCH is called to write any current line to the control tape file. An M30 code is written to the control tape file and PUNCH is called again to write the line. A FORTRAN ENDFILE is performed to close out the control tape file and control is returned to the calling routine.

```
FORTRAN V06.13          10:21:26   03-OCT-76   PAGE   1

0001        SUBROUTINE EOT
       C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C                                                      C
       C        SUBROUTINE TO GENERATE END-OF-TAPE CODE       C
       C                                                      C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C
0002        INTEGER TPTR,MODE,UNIT
0003        BYTE TAPE(80)
0004        COMMON/TAPCOM/TPTR,TAPE,MODE,UNIT
       C
0005        CALL PUNCH
0006        CALL BUILD('M',30)
0007        CALL PUNCH
0008        ENDFILE UNIT
0009        RETURN
0010        E N D

ROUTINES CALLED:
PUNCH , BUILD

OPTIONS =/ON,/OP:1

BLOCK        LENGTH
EOT      43    (000126)*
TAPCOM   43    (000126)

**COMPILER ----- CORE**
       PHASE      USED  FREE
DECLARATIVES  00622  14434
EXECUTABLES   00714  14342
ASSEMBLY      00888  18808
```

87

3.8 ERR

Purpose: Subroutine to log error messages on the line printer.

Calling Sequence and Arguments:

CALL ERR(NCODE,IRTRN)

where:

NCODE - An integer error code number.

IRTRN - Return flag.

IRTRN .NE. 0 causes return to caller.

IRTRN .EQ.0 causes program to terminate.

Called By: PLYGEN

Subroutines Called: EXIT

Diagnostics: ***ERROR n***
PLYGEN TERMINATING

Detailed Description: Subroutine ERR prints the error code number on the line printer then tests the second argument to determine whether to return to the caller or terminate execution.

```
FORTRAN V06.13                10:22:20    03-OCT-76    PAGE    1

0001           SUBROUTINE ERR(N,RFLAG)
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C                                                                 C
       C     ERROR PROCESSOR SUBROUTINE.  IT'S DONE THIS WAY SO LATER     C
       C     ON MEANINGFUL MESSAGES CAN BE PRINTED.                       C
       C                                                                 C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C
0002           INTEGER RFLAG
0003           WRITE(16,1)N
0004     1     FORMAT(1X,'**** ERROR',I3,' ****')
0005           WRITE(6,2)N
0006     2     FORMAT(6X,'?? ERROR',I3,' ??')
0007           IF(RFLAG.NE.0) RETURN
0008           WRITE(6,3)
0009           WRITE(16,3)
0010     3     FORMAT(1X,'**** PLYGEN TERMINATING ****'/)
0011           CALL EXIT
0012           E N D

ROUTINES CALLED:
EXIT

OPTIONS =/ON,/OP:1

BLOCK    140    LENGTH
ERR      140    (000430)*

**COMPILER ----- CORE**
    PHASE        USED    FREE
DECLARATIVES    00702   14354
EXECUTABLES     00702   14354
ASSEMBLY        01079   18617
```

89

3.9 GET

Purpose: Subroutine to assemble a block of data from a control tape into internal form.

Callin⸻ **nd Arguments:**

        CALL GET

Called By: Many

Subroutines Called: CLR   MOV
                           CHAR   A1A2
                           FILL

Diagnostics: None

Detailed Description: Data is retrieved from this subroutine via data arrays stored in common. These arrays are first cleared. The subroutine then gets a single character (via CHAR) which it assumes to be a control code. It searches its table of valid control code characters and dispatches to a particular routine based on the match found. The number following the control code is assembled into a temporary work buffer and converted into internal form using a FORTRAN DECODE statement. This process continues until an end-of-block character is encountered and control is returned to the caller.

```
FORTRAN V06.13            10:19:18  03-OCT-74  PAGE  1

0001      SUBROUTINE GET
     C
     CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
     C                                                             C
     C      THIS SUBROUTINE "GET" GETS A FULL LINE OF CONTROL CODES FROM  C
     C      THE "PAPER TAPE".  ARGUMENTS ARE RETURNED IN COMMON    C
     C                                                             C
     CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
     C
     C
0002      IMPLICIT INTEGER (A-Z)
0003      INTEGER WORK(9),WORKX(8),VALIDC(17)
0004      INTEGER MARK(17),IVALUE(4),GCODES(16)
0005      REAL RVALUE(17)
0006      LOGICAL SCANSW,E1AFLG,C04SW
0007      COMMON/GETCOM/N,MARK,IVALUE,RVALUE,GCODES,IC
0008      COMMON/CHRCOM/SCANSW,E1AFLG
0009      COMMON        MODE(3),C04SW
0010      DATA VALIDC/1HM,1HG,1HM,1HS,1HX,1HY,1HZ,1HA,1HC,1HD,
     1            1HI,1HJ,1HK,1HF,1E/,-1,-1/
     C
     C
0011   10 N=0
0012      IC=0
0013      C04SW=.FALSE.
0014      CALL CLR(MARK,,17)
0015      CALL CLR(IVALUE,,4)
0016      CALL CLR(RVALUE,,34)
0017      CALL CLR(GCODES,,16)
0018      C=CHAR()
     C
0019      IF(C)20,30,40
0020   20 STOP 177777
0021   30 RETURN
0022   40 DO 50 REFNUM=1,17
0023      IF(C.EQ.VALIDC(REFNUM) ) GO TO 60
0024   50 CONTINUE
0025      IC=IC+1
0026      C=CHAR()
0027      GO TO 10
0028   60 N=N+1
0029      MARK(REFNUM)=MARK(REFNUM)+1
0030      SIGN=1
0031      C=CHAR()
0032      IF(C.EQ.'-') SIGN=-1
0033      IF(SIGN.LT.0) C=CHAR()
0034      CALL FILL('  ',WORK,,8)
0035      I=0
0036   70 IF(C.LT.'0' .OR. C.GT.'9') GO TO 80
0037      I=I+1
0038      WORK(I)=C
0039      C=CHAR()
0040      IF(I.LT.8) GO TO 70
0041      IC=IC+1
```
91

```
0042            IF(I.GT.9) I=9
0043            GO TO 70
0044    80      IF(WORK(8).NE.' ' .OR. I.EQ.0) GO TO 90
0045            CALL MOV(WORK,,WORKX,,8)
0046            CALL MOV(WORKX,,WORK,2,8)
0047            WORK(1)=' '
0048            GO TO 80
0049    90      CALL A1A2(WORK,,8)
0050            GO TO (1010,1020,1030,1040,1050,1060,1070,1080,1090,1100,
0051          1       1110,1120,1130,1140,1150,1160,1170),REFNUM
        C
        C
0051    1010    DECODE(8,940,WORK) IVALUE(1)
0052            IVALUE(1)=IVALUE(1)*SIGN
0053            GO TO 10
0054    1020    I=MARK(2)
0055            IF(I.GT.16) STOP 177774
0056            DECODE(8,920,WORK) GCODES(1)
0057            GCODES(1)=GCODES(1)*SIGN
0058            IF(I.EQ.1) IVALUE(2)=GCODES(1)
0059            IF(GCODES(1).EQ.04) G04SW=.TRUE.
0060            GO TO 10
0061    1030    CONTINUE
0062    1040    DECODE(8,920,WORK) IVALUE(REFNUM)
0063            IVALUE(REFNUM)=IVALUE(REFNUM)*SIGN
0064            GO TO 10
0065    1090    DECODE(8,952,WORK) RVALUE(9)
0066            RVALUE(9)=RVALUE(9)*SIGN
0067            GO TO 10
0068    1050    CONTINUE
0069    1060    CONTINUE
0070    1070    CONTINUE
0071    1080    CONTINUE
0072    1100    CONTINUE
0073    1110    CONTINUE
0074    1120    CONTINUE
0075    1130    DECODE(8,943,WORK) RVALUE(REFNUM)
0076            IF(SIGN.GT.0) GO TO 10
0077            IF(RVALUE(REFNUM).LT.0.001) RVALUE(REFNUM)=.0001
0078            RVALUE(REFNUM)=RVALUE(REFNUM)*SIGN
0079            GO TO 10
0080    1140    IF(G04SW.EQ..FALSE.) GO TO 1130
0081            DECODE(8,932,WORK) RVALUE(14)
0082            RVALUE(14)=RVALUE(14)*SIGN
0083    1150    GO TO 10
0084    1160    STOP 177776
0085    1170    STOP 177775
        C
0086    920     FORMAT(5X,I3)
0087    932     FORMAT(F8.2)
0088    940     FORMAT(3X,I5)
0089    943     FORMAT(F8.3)
0090    952     FORMAT(F8.2)
        C
0091            E N D
```

92

ROUTINES CALLED:
CLR , CHAR , FILL , MOV , A1A2

OPTIONS =/ON,/OP:1

```
BLOCK    LENGTH
GET    832   (003200)*
.$$$$.   4   (000010)
GETCOM  73   (000222)
CHRCOM   2   (000004)
```

COMPILER ----- CORE

PHASE	USED	FREE
DECLARATIVES	00622	14434
EXECUTABLES	01051	14005
ASSEMBLY	01506	18190

3.10 HEAD

Purpose: A convenient routine that generates a single block with appropriate "M-codes" to turn the ATLS tape head on and off.

Calling Sequence and Arguments:

CALL HEAD(L)

where:

L is a logical variable.
.TRUE. generates a head on code.
.FALSE. generates a head off code.

Called By: PLYGEN

Subroutine Called: BUILD
                          PUNCH

Diagnostics: None

Detailed Description: PUNCH is called to close out the currently filled buffer. If the argument is .TRUE. then BUILD is called to generate a M62 code. If the argument if .FALSE. then BUILD is called to generate a M63 code. PUNCH is called again and the routine returns to the caller.

```
FORTRAN V06.13        10:21:00   03-OCT-76   PAGE   1

0001        SUBROUTINE HEAD(L)
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C                                                  C
       C    SUBROUTINE TO TURN AUTO HEAD ON AND OFF       C
       C    ARGUMENTS:                                    C
       C                  L - .TRUE. -- TURN AUTO HEAD ON C
       C                    - .FALSE. -- TURN AUTO HEAD OFF C
       C                                                  C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C
0002        LOGICAL L,OFF,ON
0003        DATA OFF,ON/.FALSE.,.TRUE./
       C
0004        CALL PUNCH
0005        IF(L.EQ.OFF) CALL BUILD('M',63)
0006        IF(L.EQ.ON ) CALL BUILD('M',62)
0007        CALL PUNCH
0008        RETURN
0009        E N D

ROUTINES CALLED:
PUNCH . BUILD

OPTIONS =/ON,/OP:1

BLOCK      LENGTH
HEAD   74    (000224)*

**COMPILER ----- CORE**
   PHASE      USED   FREE
DECLARATIVES  00622  14434
EXECUTABLES   00783  14273
ASSEMBLY      00919  18777
```

95

3.11 MOVE

Purpose: Subroutine to generate block of control tape containing up to six axes of data and an N-code.

Calling Sequence and Arguments:

CALL MOVE (X,Y,Z,A,C,D,N)

where:

X,Y,Z,A,C,D are real variables containing the respective axis information.

N is an integer variable containing the N-code.

Called By: PLYGEN

Subroutines Called: NULARG
PUNCH
BUILD

Diagnostics: None

Detailed Description: PUNCH is called to flush the buffer. Each argument is tested to see if it exists using subroutine NULARG and if it does, BUILD is called with the appropriate parameters. PUNCH is called again to close out this block.

```
FORTRAN V06.13          10:19:57   03-OCT-76   PAGE    1

0001       SUBROUTINE MOVE(X,Y,Z,A,C,D,N)
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC   C
       C                                                                 C
       C   SUBROUTINE TO DO A MOVE IN UP TO ALL 6 AXIS                    C
       C   UNNECESSARY ARGUMENTS CANN BE OMITTED (MADE NULL).             C
       C                                                                 C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC

0002       REAL X,Y,Z,A,C,D
0003       INTEGER N
0004       LOGICAL NULARG
       C
0005       CALL PUNCH
0006       IF(NULARG(7).EQ..FALSE.) CALL BUILD('N',N)
       C
0007       IF(NULARG(1).EQ..FALSE.) CALL BUILD('X',X)
0008       IF(NULARG(2).EQ..FALSE.) CALL BUILD('Y',Y)
0009       IF(NULARG(3).EQ..FALSE.) CALL BUILD('Z',Z)
0010       IF(NULARG(4).EQ..FALSE.) CALL BUILD('A',A)
0011       IF(NULARG(5).EQ..FALSE.) CALL BUILD('C',C)
0012       IF(NULARG(6).EQ..FALSE.) CALL BUILD('D',D)
0013       CALL PUNCH
0014       RETURN
0015       E N D

ROUTINES CALLED:
NULARG, PUNCH , BUILD

OPTIONS =/ON,/OP:1

BLOCK    LENGTH
MOVE     217  (000662)*

**COMPILER ----- CORE**
     PHASE      USED  FREE
DECLARATIVES  000622 14434
EXECUTABLES   00863  14193
ASSEMBLY      00995  18701
```

97

3.12 MSG

Purpose: To print an alpha-numeric on the graphic terminal.

Calling Sequence and Arguments:

CALL MSG(STRING)

where:

STRING is a byte containing up to 23 characters terminated by a character of binary zeros.

Called By: ATLSGR et. al.

Subroutines Called: ANMODE   NEWLIN
ANCHO   BELL

Diagnostics: None

Detailed Description: The graphics subroutines are called to prepare the terminal for character output and to write out the argument string. The cursor is positioned to a new line and the bell on the terminal is rung as an audible signal to the operator to respond.

```
FORTRAN V06.13              10:18:47      03-OCT-76   PAGE   1

0001      SUBROUTINE MSG(STRING)
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C                                                             C
      C   SUBROUTINE TO PRINT A MESSAGE ON THE TUBE.               C
      C   CURSOR IS ASSUMED TO BE POSITIONED AT THE LEFT MARGIN SOMEWHEREC
      C   CR/LF IS DONE AFTER MESSAGE IS PRINTED.                  C
      C                                                             C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C
0002          BYTE STRING(23)
0003          CALL ANMODE
0004          DO 1 I=1,23
0005          IF(STRING(I).EQ.0) GO TO 2
0006    1     CALL ANCHO(STRING(I))
0007    2     CALL NEWLIN
0008          CALL BELL
0009          RETURN
0010          E N D


ROUTINES CALLED:
ANMODE, ANCHO , NEWLIN, BELL

OPTIONS =/ON,/OP:1

BLOCK       LENGTH
MSG    89   (000262)*

**COMPILER ----- CORE**
    PHASE    USED  FREE
DECLARATIVES 00622 14434
EXECUTABLES  00783 14273
ASSEMBLY     00955 18741
```

3.13 PCHAR/PCLOSE (Assembly Language)

Purpose: Subroutine to punch binary characters to paper tape.

Calling Sequence and Arguments:

CALL PCHAR(BYTE)

where:

BYTE is any 8-bit character.

Called By: PTDUMP

Subroutines Called: None

Diagnostics: None

Detailed Description: Since PDP-11 FORTRAN does not support punching the arbitrary sequences of characters required to form an ATLS control tape, this subroutine is written in assembly language. On first entry, some one-time code is executed to INIT and OPEN the logical dataset OUT. Subsequent entries put bytes one at a time into an output buffer and when the buffer is filled, it is written out.

PCLOSE is an alternate entry that must be called prior to terminating execution of the calling program. This entry writes out the partially filled local buffer and closes the dataset.

```
PCHAR - PUNCH CHARACTER.              MACRO V06-03 03-OCT-76 10:22 PAGE 1

    1                                  .NLIST TTM
    2                                  .NLIST SYM
    3                                  .TITLE PCHAR - PUNCH CHARACTER.
    4                                  .DSABL GBL
    5                                  .ENABL AMA
    6                                  .ENABL LSB
    7
    8                          ; SUBROUTINE TO PUNCH CHARACTERS TO PAPER TAPE.  FORTRAN I/O
    9                          ; DOES FORMATTED ASCII TRANSFERS WHICH IS UNACCEPTABLE, SO THIS ROUTINE
   10                          ; DOES UNFORMATTED TRANSFERS.
   11                          ;
   12                          ;
   13                                  .MCALL .INIT,.OPEN,.WRITE,.WAIT,.CLOSE,.RLSE
                                       .GLOBL PCHAR
   14 000000 000401    PCHAR:  BR    .+4              ; GO DO ONE TIME CODE.
   15 000002 000412            BR    10$              ; SKIP ONE TIME CODE.
   16 000004 105037 000000'    CLRB  PCHAR            ; RESET ONE TIME SWITCH.
   17 000010                   .INIT #LB,#FB          ; INITIALIZE THE DATA SET.
   18 000016                   .OPEN                  ; OPEN THE FILE.
   19 000030 117577 000134 10$: MOVB  @2(R5),@DATPTR  ; SAVE THIS CHAR.
   20 000036 005237 000172'    INC   DATPTR           ; BUMP THE DATA POINTER.
   21 000042 023727 000172'    CMP   DATPTR,#BUFEND   ; IS THE BUFFER FULL?
   22 000050 103422            BLO   11$              ; NO, RETURN.
   23 000052 013737 000172'    MOV   DATPTR,BUFHDR+4  ; GET CURRENT DATA POINTER.
   24 000060 162737 000200'    SUB   #BUFHDR+6,BUFHDR+4 ; SUBTRACT START ADDRESS OF BUFFER.
   25 000066 001413            BEQ   11$              ; NO DATA (ONLY POSSIBLE ON CLOSE.)
   26 000070 012737 000200'    MOV   #BUFHDR+6,DATPTR ; RESET THE DATA POINTER.
   27 000076                   .WRITE #LB,#BUFHDR     ; WRITE OUT THIS BLOCK.
   28 000110                   .WAIT #LB              ; *
   29 000116 000205      11$:  RTS   R5               ; RETURN TO CALLER.
   30                          ;
   31                                  .GLOBL PCLOSE
   32 000120 004537 000052' PCLOSE: JSR R5,WRITE      ; WRITE LAST PARTIAL BUFFER.
   33 000124                   .CLOSE #LB             ; CLOSE THE FILE.
   34 000132                   .RLSE #LB              ; RELEASE IT AS WELL.
   35 000140 000205            RTS   R5               ; RETURN TO CALLER!
   36                          ;
   37                          ; BUFFERS ETC.
   38                          ;
   39 000142 000144'     LB =  .+2                    ; LINK BLOCK.
   40 000142 000000            .WORD 0,0
   41 000146 060434            .RAD50 /OUT/
   42 000152 001               .BYTE 1,0
   43        063200            .RAD50 /PP/
   44                          ;
   45 000154 000160'     FB =  .+4                    ; FILE BLOCK.
   46 000154 000000            .WORD 0,2,0,0,0,0,0
          000162 000000
          000170 000000
   47                          ;
   48 000100            BUFSIZ = 100                  ; BUFFER SIZE.
   49 000172 000202'    DATPTR: .WORD BUFHDR+6        ; LOCAL DATA POINTER.
   50 000174 000100     BUFHDR: .WORD BUFSIZ,3,0      ; BUFFER HEADER.
          000176 000003
   51 000202 000100            .BLKB BUFSIZ           ; BUFFER.
   52 000302'            BUFEND = .                   ; BUFFER END.
   53                          ;
   54 000001'                  .END

ERRORS DETECTED: 0
```

3.14 PUNCH

Purpose: Subroutine to write out an accumulated block of control
tape data.

Calling Sequence and Arguments:

    CALL PUNCH

Called By: PLYGEN et. al.

Subroutine Called: None

Detailed Description: Arguments are passed between PUNCH and BUILD via
common. Upon entry, the buffer pointer is used to calculate the length of
the output string. If this length is greater than zero, the buffer is
written. The buffer pointer is then reset to the beginning of the buffer
and a return is made to the main program.

```
FORTRAN V06.13            10:22:09   03-OCT-76   PAGE   1

0001         SUBROUTINE PUNCH
       C CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC   C
       C                                                                        C
       C     PUNCH THE CURRENT CONTENTS OF THE TAPE BUFFER.                     C
       C     IF THE CURRENT BUFFER IS EMPTY, DO NOTHING.                        C
       C                                                                        C
       C CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC   C
       C
0002         BYTE TAPE(80)
0003         INTEGER TPTR,MODE,UNIT
0004         COMMON/TAPCOM/TPTR,TAPE,MODE,UNIT
       C
0005         TPTR=TPTR-1
0006         IF(TPTR.GT.0) WRITE(UNIT,100)(TAPE(I),I=1,TPTR)
0007   100   FORMAT(80A1)
0008         TPTR=1
0009         RETURN
0010         E N D

OPTIONS =/ON,/OP:1

BLOCK     LENGTH
PUNCH     68    (000210)*
TAPCOM    43    (000126)

**COMPILER ----- CORE**
     PHASE      USED    FREE
DECLARATIVES  00622   14434
EXECUTABLES   00714   14342
ASSEMBLY      00964   18732
```

3.15 RESET

Purpose: Subroutine that accepts operator input to modify the graphic
transformation matrices used in the graphics program.

Calling Sequence and Arguments:

        CALL RESET

Called By: ATLSGR

Subroutines Called: ABS   R8MOVE
                         MOVABS   R8ID
                         MSG   COS
                         ANSWER   SIN
                         MOVB   VWINDO
                         R8MULT   FINITT
                         VCURSR

Diagnostics: **INVALID COMMAND**

Detailed Description: The transformation matrices are passed between
SETUP, RESET, and ATLSGR in common. Subroutine RESET asks the operator to
enter a command and waits for a response. The single letter starting the
response is decoded as a unique command code and an internal table of valid
characters is searched for a match. A match causes control to be transferred
to a routine that decodes the remaining input as needed and makes the re-
quested matrix modifications.

All commands except two go back for more input from the operator.
These special commands are:

    1. "D" (draw) - returns control to caller.

    2. "E" (exit) - terminates execution.

```
FORTRAN V06.13          10:17:53   03-OCT-76   PAGE    1

0001        SUBROUTINE RESET
        C
        CCCCCCCCCCCCCCCCCC CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        C                                                                 C
        C   THIS SUBROUTINE TALKS TO THE OPERATOR AND GETS OPTIONS TO     C
        C   MODIFY THE VARIOUS TRANSFORMATION MATRICIES.                  C
        C                                                                 C
        CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        C
0002          REAL*8 T(4,4),S(4,4),P(4,4),SDTM(4,4),V
0003          REAL*8 T0(4,4),S0(4,4),TSAVE(4,4),SSAVE(4,4),HSAVE,VSAVE
0004          REAL*8 TEMP1(4,4),TEMP2(4,4)
0005          BYTE ANS(24),CMND(12),BLANK,CR,SLASH,C
        C
0006          COMMON/TEMP  /TEMP1,TEMP2
0007          COMMON/SAVE   T0,S0,TSAVE,SSAVE,HSAVE,VSAVE
0008          COMMON/SDTM CA/T,S,P,SDTM,V
0009          DATA CMND/'D','C','S','X','Y','Z','H','M','R','O','V','E'/
0010          DATA BLANK,CR,SLASH/' ',13,'/'/
        C
0011          HLAST=1.0D0/P(3,4)
0012          SLAST=S(4,3)
0013          VLAST=VSAVE
0014          SFACT=(ABS(HLAST)+ABS(SLAST))/ABS(HLAST)
0015          CALL MOVABS(0,700)
0016    1     CALL MSG('ENTER COMMAND')
0017          CALL ANSWER(ANS)
0018          C=ANS(1)
0019          CALL MOVB(ANS,1,ANS,,23)
0020          DO 4 I=1,24
0021          IF(ANS(I).EQ.CR .OR. ANS(I).EQ.0) GO TO 5
0022    4     CONTINUE
0023          I=23
0024    5     ANS(I)=','
0025          I=I+1
0026          DO 6 J=I,24
0027          ANS(J)=BLANK
0028    6     DO 2 I=1,12
0029          IF(C.EQ.CMND(I)) GO TO (10,20,30,40,50,60,70,80,90,100,110,999),I
0030    2     CONTINUE
0031    3     CALL MSG('**INVALID COMMAND**')
0032          GO TO 1
        C
        C - - DRAW COMMAND.
        C
0033    10    CALL R8MULT(T,S,TEMP1,4,4,4)
0034          CALL R8MULT(TEMP1,P,SDTM,4,4,4)
0035          RETURN
        C
        C - - CENTER COMMAND.
        C
0036    20    CALL MSG('SET JOYSTICK TO CENTER')
0037          CALL VCURSR(ICHAR,X,Y)
0038    21    T(4,1)=T(4,1)-X*SFACT
```

105

```
0039          T(4,2)=T(4,2)-Y*SFACT
0040          GO TO 1
         C
         C     S - - SCALE COMMAND.
         C
0041  30     CALL MSG('SET JOYSTICK TO CORNER')
0042          CALL VCURSR(ICHAR,X,Y)
0043          CALL MSG('NOW DO OTHER CORNER')
0044          CALL VCURSR(ICHAR,XX,YY)
0045          XDEL=ABS(X-XX)
0046          YDEL=ABS(Y-YY)
0047          SIZE=XDEL
0048          IF(XDEL.LT.YDEL) SIZE=YDEL
0049          IF(SIZE.EQ.0.0) GO TO 3
0050          SIZE=SIZE*SFACT
0051          SIZEX=ABS(HLAST)+ABS(SLAST)-SIZE*ABS(HLAST)/VLAST
0052          S(4,3)=S(4,3)+SIZEX
0053          X=(X+XX)/2
0054          Y=(Y+YY)/2
0055          GO TO 21
         C
         C     X - - X ROTATION.
         C
0056  40     IFLAG=2
0057          JFLAG=3
0058          GO TO 61
         C
         C     Y - - Y ROTATION.
         C
0059  50     IFLAG=1
0060          JFLAG=3
0061          GO TO 61
         C
         C     Z - - Z ROTATION.
         C
0062  60     IFLAG=1
0063          JFLAG=2
0064  61     DECODE(7,71,ANS)ROT
0065          CALL R8MOVE(T,TEMP1,4,4)
0066          CALL R8ID(TEMP2,4)
0067          ROT=ROT*3.14159265/180.0
0068          TEMP2(IFLAG,IFLAG)=COS(ROT)
0069          TEMP2(JFLAG,JFLAG)=COS(ROT)
0070          TEMP2(IFLAG,JFLAG)=-SIN(ROT)
0071          TEMP2(JFLAG,IFLAG)=SIN(ROT)
0072          CALL R8MULT(TEMP1,TEMP2,T,4,4,4)
0073          GO TO 1
         C
         C     H - - RESET EYEPOINT DISTANCE.
         C
0074  70     DECODE(7,71,ANS)HNEW
0075  71     FORMAT(F12.0)
0076          P(3,4)=-1.0/HNEW
0077          GO TO 1
         C
         C     M - - MARK (SAVE) CURRENT STATUS.
         C
```

```
0078    80    CALL RBMOVE(T,TSAVE,4,4)
0079          CALL RBMOVE(S,SSAVE,4,4)
0080          BSAVE=P(3,4)
0081          VSAVE=V
0082          GO TO 1
        C
        C     R - - RESTORE LAST SAVED STATUS.
0083    90    CALL RBMOVE(TSAVE,T,4,4)
0084          CALL RBMOVE(SSAVE,S,4,4)
0085          P(3,4)=BSAVE
0086          V=VSAVE
0087          GO TO 1
        C
        C     O - - ORIGINAL STATUS RESTORED HERE.
0088    100   CALL RBMOVE(T0,T,4,4)
0089          CALL RBMOVE(S0,S,4,4)
0090          P(3,4)=-1.0D0/12.0D0
0091          V=6.0
0092          GO TO 1
        C
        C     V - - SET VWINDO HERE.
0093    110   DECODE(7,71,ANS)VV
0094          IF(VV.LE.0.0) GO TO 3
0095          V=VV
0096          GO TO 1
        C
        C     E - - EXIT HERE.
0097    999   CALL FINITT(0,780)
0098          E N D
```

ROUTINES CALLED:
ABS , MDVABS, MSC   , ANSWER, MOVB , RBMULT, VCURSR
RBMOVE, RBID , COS   , SIN , FINITT

OPTIONS =/ON./OP:1

```
BLOCK         LENGTH
RESET   1116    (004270)*
TEMP    128     (000400)
SAVE    264     (001020)
SDTMCA  260     (001010)

**COMPILER ----- CORE**
PHASE        USED   FREE
DECLARATIVES 00622  14434
EXECUTABLES  01460  13596
ASSEMBLY     01666  18030
```

3.16 SETUP

Purpose: Subroutine to initialize graphic transformation matrices.

Calling Sequence and Arguments:

CALL SETUP(IFLAG)

where:

IFLAG.NE.0 causes a special diagnostic
dump to the line printer.

Called By: ATLSGR

Subroutines Called: GET   R8MOVE
                     CHAR   R8MULT
                     R8ID   DELETE

Diagnostics: None

Detailed Description: All transformation matrices are initialized except
for the initial linear transform matrix (T). T is initialized by scanning
through the input control tape file and calculating average X, Y and Z de-
viations. These averages are used to roughly center the picture for its
first drawing.

```
0001          SUBROUTINE SETUP(IFLAG)
       C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C                                                                C
       C     THE FOLLOWING ROUTINE SETS UP THE MASTER TRANSFORM MATRIX  C
       C     "SDTM" IN COMMON AREA "SDTMCA".                            C
       C     IF THE ARGUMENT "IFLAG" IS NOT EQUAL TO ZERO, SETUP WILL   C
       C     DUMP THE INTERMEDIATE ARRAYS ONTO DEVICE 6                 C
       C                                                                C
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       C
0002          IMPLICIT INTEGER (A-Z)
0003          REAL*8 T(4,4),S(4,4),P(4,4),SDTM(4,4),V
0004          REAL*8 T0(4,4),S0(4,4),TSAVE(4,4),SSAVE(4,4),HSAVE,VSAVE
0005          REAL*8 TEMP1(4,4),TEMP2(4,4),H
       C
0006          INTEGER MARK(17),IVALUE(4),GCODES(16)
0007          REAL*4 RVALUE(17)
0008          LOGICAL SCANSW,EIAFLG,C04SW
       C
0009          REAL*4 XMIN,XMAX,XAVE,YMIN,YMAX,YAVE,ZMIN,ZMAX,ZAVE,XDEL,YDEL,ZDEL
0010          INTEGER XCOUNT,YCOUNT,ZCOUNT,TCOUNT
       C
0011          COMMON/SDTMCA/T,S,P,SDTM,V
0012          COMMON/SAVE   /T0,S0,TSAVE,SSAVE,HSAVE,VSAVE
0013          COMMON/TEMP   /TEMP1,TEMP2
0014          COMMON/GETCOM/N,MARK,IVALUE,RVALUE,GCODES,IC
0015          COMMON/CHRCOM/SCANSW,EIAFLG
0016          COMMON           MODE(3),C04SW
       C
0017          DATA XMIN,YMIN,ZMIN,XMAX,YMAX,ZMAX/3*1.0E9,3*-1.0E9/
0018          DATA XCOUNT,YCOUNT,ZCOUNT,TCOUNT/4*0/
       C
0019          V=6.0
       C
       C----CALCULATE DATA FOR THE INITIAL TRANSFORMATION.
       C
0020   100    SCANSW=.TRUE.
0021   105    CALL GET
0022          IF(MARK(3).LE.0 .OR. IVALUE(3).NE.62) GO TO 105
0023   110    CALL GET
0024          IF(MARK(3).LE.0) GO TO 120
0025          IF(IVALUE(3).EQ.02 .OR.
              1   IVALUE(3).EQ.03 .OR.
              2   IVALUE(3).EQ.30        ) GO TO 130
       C
0026   120    IF(MARK(5).EQ.0 .AND. MARK(6).EQ.0 .AND. MARK(7).EQ.0)
              1  GO TO 110
       C
0027          IF(MARK(5).LE.0) GO TO 121
0028          XCOUNT=XCOUNT+1
0029          XAVE=XAVE+RVALUE(5)
0030          IF(RVALUE(5).LT.XMIN) XMIN=RVALUE(5)
0031          IF(RVALUE(5).GT.XMAX) XMAX=RVALUE(5)
```

109

```
0032    C
0032    121     IF(MARK(6).LE.0) GO TO 122
0033            YCOUNT=YCOUNT+1
0034            YAVE=YAVE+RVALUE(6)
0035            IF(RVALUE(6).LT.YMIN) YMIN=RVALUE(6)
0036            IF(RVALUE(6).GT.YMAX) YMAX=RVALUE(6)
0037    C
0037    122     IF(MARK(7).LE.0) GO TO 123
0038            ZCOUNT=ZCOUNT+1
0039            ZAVE=ZAVE+RVALUE(7)
0040            IF(RVALUE(7).LT.ZMIN) ZMIN=RVALUE(7)
0041            IF(RVALUE(7).GT.ZMAX) ZMAX=RVALUE(7)
0042    C
0042    123     TCOUNT=TCOUNT+1
0043            GO TO 110
        C
        C-----SCAN FOR END-OF-FILE ON INPUT AND RESET SCAN SWITCH.
0044    130     IF(CHAR().GE.0) GO TO 130
0045            SCANSW=.TRUE.
        C
        C-----CALCULATE AVERAGES.
        C
0046            XAVE=XAVE/TCOUNT
0047            YAVE=YAVE/TCOUNT
0048            ZAVE=ZAVE/TCOUNT
        C
        C-----SETUP THE FIRST TRANSLATION MATRIX HERE.
        C
0049            CALL RBID(T,4)
0050            T(4,1)=-XAVE
0051            T(4,2)=-YAVE
0052            T(4,3)=-ZAVE
        C
        C-----SETUP INITIAL X ROTATION HERE.
        C
0053            CALL RBMOVE(T,TEMP1,4,4)
0054            CALL RBID(TEMP2,4)
0055            TEMP2(2,2)=0
0056            TEMP2(3,3)=0
0057            TEMP2(3,2)=1
0058            TEMP2(2,3)=-1
0059            CALL RBMULT(TEMP1,TEMP2,T,4,4,4)
        C
        C-----SETYP INITIAL Y ROTATION HERE.
        C
0060            CALL RBMOVE(T,TEMP1,4,4)
0061            CALL RBID(TEMP2,4)
0062            TEMP2(1,1)=0
0063            TEMP2(3,3)=0
0064            TEMP2(3,1)=1
0065            TEMP2(1,3)=-1
0066            CALL RBMULT(TEMP1,TEMP2,T,4,4,4)
        C
        C-----SETUP INITIAL Z ROTATION HERE.
        C
```

110

```
0067        CONTINUE
       C
       C-----SETUP SCALING MATRIX (S) HERE.
       C
0068        CALL R8ID(S,4)
0069        XDEL=(2.0*(XMAX-XMIN)-H)
0070        YDEL=(2.0*(YMAX-YMIN)-H)
0071        ZDEL=(2.0*(ZMAX-ZMIN)-H)
0072        IF(XDEL.GE.0.0)  XDEL=XDEL*1.10
0073        IF(XDEL.LT.0.0)  XDEL=XDEL*0.90
0074        IF(YDEL.GE.0.0)  YDEL=YDEL*1.10
0075        IF(YDEL.LT.0.0)  YDEL=YDEL*0.90
0076        IF(ZDEL.GE.0.0)  ZDEL=ZDEL*1.10
0077        IF(ZDEL.LT.0.0)  ZDEL=ZDEL*0.90
0078        S(4,3)=-XDEL
0079        IF(YDEL.GT.XDEL) S(4,3)=-YDEL
       C
       C-----SETUP PROJECTIVE TRANSFORMATION MATRIX (P) HERE.
       C
0080        CALL R8ID(P,4)
0081        H=12.0D0
0082        P(3,3)=0.0
0083        P(3,4)=-1.0D0/H
       C
       C-----DO MAIN TRANSFORM CALCULATION HERE.
       C
0084        CALL R8MULT(T,S,TEMP1,4,4,4)
0085        CALL R8MULT(TEMP1,P,SDTM,4,4,4)
       C
       C-----SETUP SAVE MATRICIES.
       C
0086        CALL R8MOVE(T,T0,4,4)
0087        CALL R8MOVE(S,S0,4,4)
0088        CALL R8MOVE(T,TSAVE,4,4)
0089        CALL R8MOVE(S,SSAVE,4,4)
0090        HSAVE=P(3,4)
0091        VSAVE=V
       C
0092        IF(IFLAG.EQ.0) RETURN
       C
       C-----DO THE DIAGNOSTIC DUMP STUFF.
       C
0093        CALL DELETE(6)
0094        NAME='T'
0095        WRITE(6,901)NAME,((T(I,J),J=1,4),I=1,4)
0096        NAME='S'
0097        WRITE(6,901)NAME,((S(I,J),J=1,4),I=1,4)
0098        NAME='P'
0099        WRITE(6,901)NAME,((P(I,J),J=1,4),I=1,4)
0100        NAME='SD'
0101        WRITE(6,901)NAME,((SDTM(I,J),J=1,4),I=1,4)
0102        WRITE(6,902)XMAX,XMIN,XAVE,XCOUNT,
      1              YMAX,YMIN,YAVE,YCOUNT,
      2              ZMAX,ZMIN,ZAVE,ZCOUNT
0103        RETURN
```

```
0104  901  FORMAT(////,' MATRIX NAME = ',A2,4(//16X,4D14.6))
0105  902  FORMAT(////10X,'   MAX        MIN        AVE       COUNT'
      1     /10X,'********** ********** ********** ********** **********'
      2     /5X,'X ->',3F10.3,3X,I5
      3     /5X,'Y ->',3F10.3,3X,I5
      4     /5X,'Z ->',3F10.3,3X,I5)
0106       E N D

ROUTINES CALLED:
GET , CHAR , RBID , RBMOVE, RBMULT, DELETE

OPTIONS =/ON,/OP:1

BLOCK     LENGTH
SETUP    1340  (005170)*
.$$$$.      4  (000010)
SDTMCA    260  (001010)
SAVE      264  (001020)
TEMP      128  (000400)
GETCOM     73  (000222)
CHRCOM      2  (000004)

**COMPILER ----- CORE**
  PHASE       USED  FREE
DECLARATIVES 00622 14434
EXECUTABLES  01408 13648
ASSEMBLY     01849 17847
```

3.17 SHEAR

Purpose: Subroutine to output a shear code to the control tape.

Calling Sequence and Arguments:

CALL SHEAR

Called By: PLYGEN

Subroutines Called: PUNCH
BUILD

Diagnostics: None

Detailed Description: PUNCH is called to flush the buffer. BUILD is called to generate an M80 code and PUNCH is again called before returning.

113

```
FORTRAN V06.13          10:20:39   03-OCT-76   PAGE   1

0001      SUBROUTINE SHEAR
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C                                                          C
      C     SUBROUTINE TO TURN ON THE SHEAR.                     C
      C                                                          C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C
0002      CALL PUNCH
0003      CALL BUILD('M',80)
0004      CALL PUNCH
0005      RETURN
0006      E N D

ROUTINES CALLED:
PUNCH , BUILD

OPTIONS =/ON,/OP:1

BLOCK   36    LENGTH
SHEAR         (000110)*

**COMPILER ----- CORE**
     PHASE      USED  FREE
DECLARATIVES 00622 14434
EXECUTABLES  00702 14354
ASSEMBLY     00859 18837
```

114

3.18 SLIT

Purpose: A convenient routine that generates a single block with the appropriate "M-code" to turn the tape slitters on or off. (Boeing has modified ATLS so that the slitter functions operate a rewind function on the fiberglass tape supply reel.)

Calling Sequence and Arguments:

CALL SLIT(L)

where:

L is a logical variable.
.TRUE. generates a slitter on code.
.FALSE. generates a slitter off code.

Called By: PLYGEN

Subroutines Called: BUILD
                        PUNCH

Diagnostics: None

Detailed Description: PUNCH is called to close out the currently filled buffer. If the argument is .TRUE. then BUILD is called to generate a M64 code. If it is .FALSE. then a M65 code is generated. PUNCH is called again before returning.

```
FORTRAN V06.13            10:20:49   03-OCT-76   PAGE   1

0001        SUBROUTINE SLIT(L)
        C
        CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        C                                                       C
        C   SUBROUTINE TO TURN SLITTERS ON OR OFF               C
        C   ARGUMENTS:                                          C
        C                                                       C
        C        L - .TRUE. -- SLITTERS ON                      C
        C            .FALSE. -- SLITTERS OFF                    C
        C                                                       C
        CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        C
0002        LOGICAL L,OFF,ON
0003        DATA OFF,ON/.FALSE.,.TRUE./
        C
0004        CALL PUNCH
0005        IF(L.EQ.OFF) CALL BUILD('M',65)
0006        IF(L.EQ.ON ) CALL BUILD('M',64)
0007        CALL PUNCH
0008        RETURN
0009        E N D

ROUTINES CALLED:
PUNCH , BUILD

OPTIONS =/ON,/OP:1

BLOCK   LENGTH
SLIT    74    (000224)*

**COMPILER ----- CORE**
      PHASE      USED    FREE
DECLARATIVES  00622   14434
EXECUTABLES   00783   14273
ASSEMBLY      00919   18777

116
```

4. SUBROUTINES FROM IITRI'S GENERAL UTILITY LIBRARY

A1A2   - Pack one ASCII character per word into two per word.

CLR   - Clear word arrays to binary zeros.

CLRB   - Clear byte arrays to binary zeros.

CMPB   - Compare byte arrays.

DELETE - Delete the file associated with a FORTRAN logical unit
           number from the system data storage.

EIA2A   - Convert EIA codes to ASCII codes.

FILL   - Fill word arrays with a constant.

FILLB   - Fill byte arrays with a constant.

MOV   - Move word arrays in memory.

MOVB   - Move byte arrays in memory.

MRL   - Convert ASCII strings to binary man-readable leader strings.

NULARG - Determine if the caller was called with a non-existent argument.

R8ID   - Initialize a REAL*8 array with the identity matrix.

R8MOVE - Move a REAL*8 matrix in memory.

R8MULT - Multiply two REAL*8 matrices.

5. <u>SUBROUTINES FROM PDP-11 UTILITY LIBRARY</u>

ABS   - Get real absolute value.

ASSIGN - Associate a FORTRAN logical unit number with a filename
          of a file stored in the system data storage.

COS   - Cosine function.

DATE   - Retrieve current date in ASCII.

EXIT   - Terminate Execution.

SIN   - Sine function.

SQRT   - Square root function.

TIME   - Retrieve current time in ASCII.

118

6. SUBROUTINES FROM GRAPHIC SUPPORT LIBRARY

    ANCHO   - Output an alpha-numeric character.

    ANMODE - Condition graphics terminal for alpha-numeric output.

    BELL   - Ring bell on terminal.

    DRWABS - Draw a line using real screen coordinates.

    DRAWA   - Draw a line using virtual screen coordinates.

    ERASE   - Erase the screen.

    FINITT - Final cleanup processing.

    INITT   - Initialization processing.

    MOVABS - Move the graphics cursor using real screen coordinates.

    MOVEA   - Move the graphics cursor using virtual screen coordinates.

    NEWLINE - Position cursor on beginning of next input line.

    SWINDO - Define the available real viewing area on the display screen.

    VCURSR - Obtain virtual screen coordinates for the graphics input
               cross-hair cursor.

    VWINDO - Specify virtual coordinate range for the real screen window.

    TINPUT - Get a keyboard input character.

APPENDIX D

ATLS SOFTWARE SYSTEM
SAMPLE INPUT AND OUTPUT

TABLE OF CONTENTS

for Appendix D

1. PLYGEN List Output Showing Input Language For "Root Loop" and
   Mandrel Descriptions.

PLYGEN V1.0   27-AUG-76   13:49:38   PAGE   1

        ****
        *   *
        *   CH47FRB Root Loop Program.   *
        *   *
        *   Data taken from Boeing Vertol drawing #114R1710   *
        *   *
        ****
        *
        *
  1)   CYLTRAVEL 0
  2)   THICKNESS .0095
  3)   MANDREL(1) 0, 0, -1.75, 3.5
  4)   MANDREL(2) -29.5, 0, -1.75, -24.830, -19.330, -12.330
        *
  5)   REFSTATION 29.5
        *
  6)   PLY 1   = 34.5
  7)   PLY 58 = 45.0
  8)   PLY 71 = 50.5
  9)   PLY 72 = 55.0
 10)   PLY 80 = 60.0
 11)   PLY 88 = 65.0
 12)   PLY 99 = 70.0
 13)   PLY 110 = 77.0
 14)   PLY 122 = 117.0
 15)   PLY 126 = 124.0
 16)   PLY 127 = 134.0
 17)   PLY 133 = 306.0
 18)   PLY 134 = 363.0
 19)   PLY 144 = 363.0
        *
 20)   BREAK 51
        *
 21)   E N D

        TOTAL FIBERGLASS TAPE LENGTH: PART 1 =   108.2 FT
                                      PART 2 =   846.5 FT

122

2. <u>Sample Graphical Output from ATLSGR:</u>

- Four Similar Views of IITRI Test Tape.

- Four Views of Original Boeing Tape.

CH47FRB Root Loop (IITRI generated)
Ply 1 thru 50
View 1.

ENTER COMMAND

124
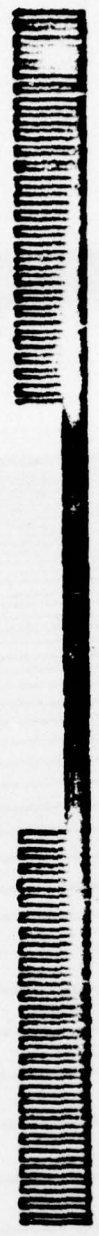
CH47FRB Root Loop (IITRI generated

Ply 1 thru 50

View 2.

ENTER COMMAND

125
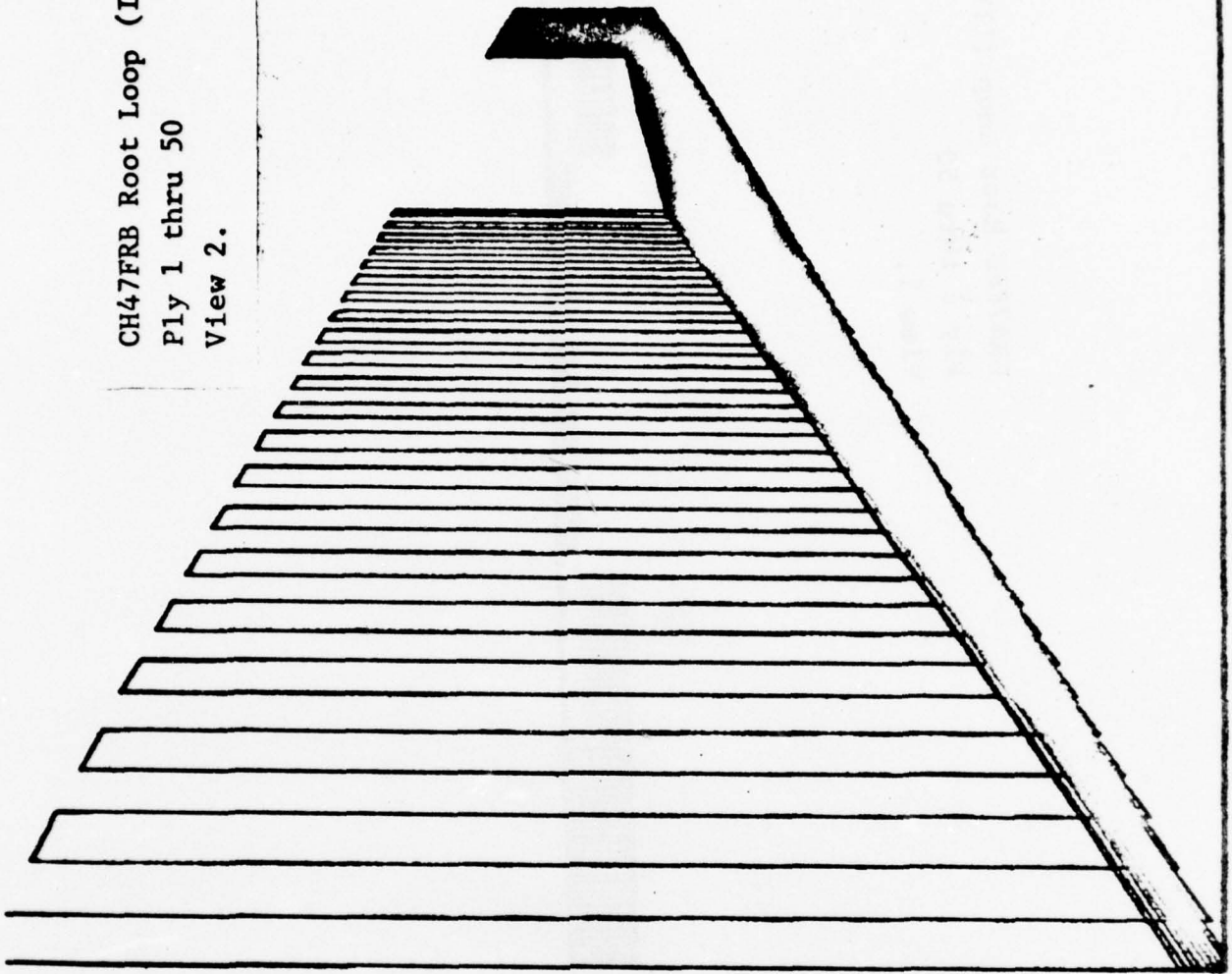
CH47FRB Root Loop (IITRI generate

Ply 1 thru 50

View 3.

ENTER COMMAND

CH47FRB Root Loop (IITRI generated)
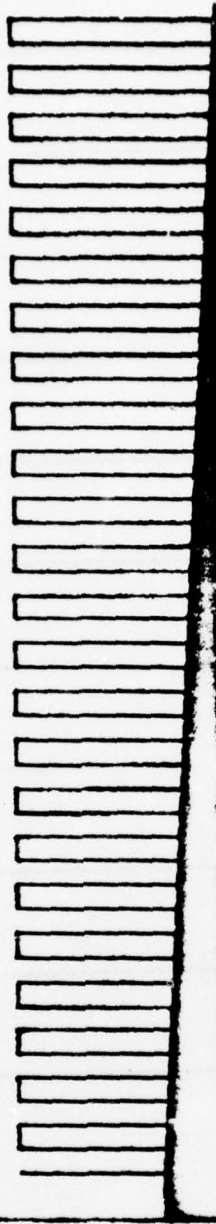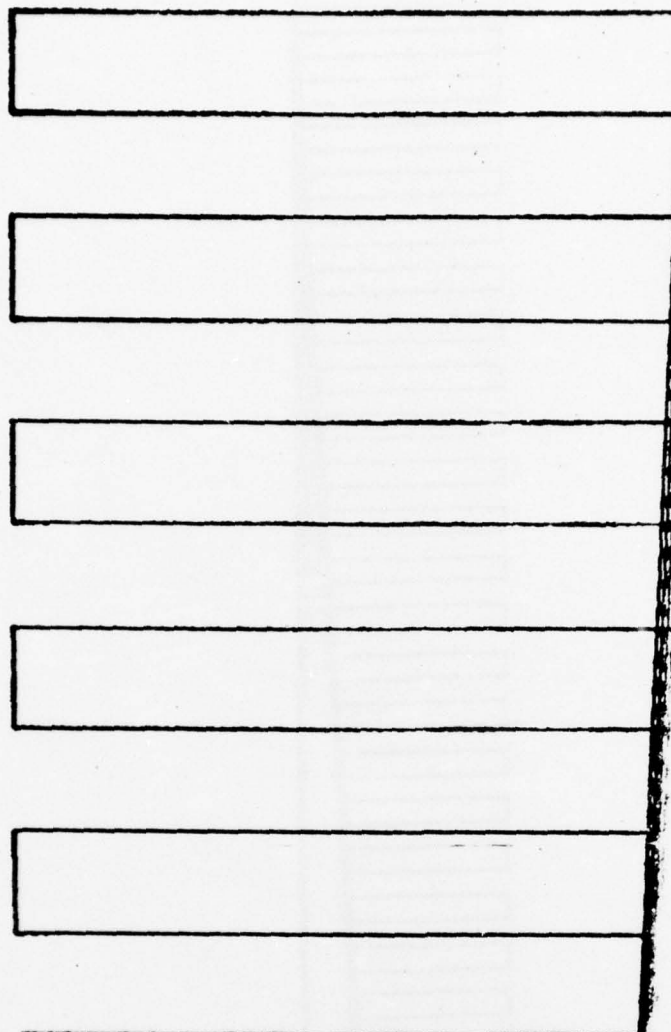
Ply 1 thru 50

View 4.

ENTER COMMAND

CH47FRB Root Loop

Ply 1 thru 50

View 1.

ENTER COMMAND

128

CH47FRB Root Loop
Ply 1 thru 50
View 2.
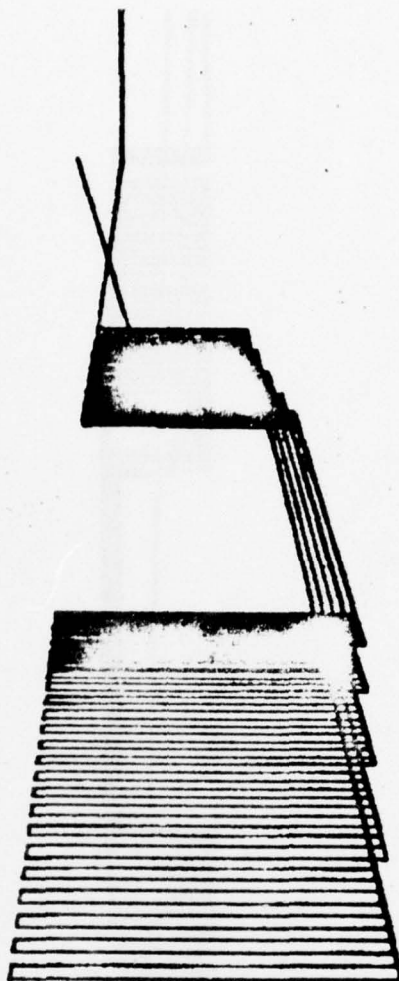
ENTER COMMAND

CH47FRB Root Loop
Ply 1 thru 50
View 3.
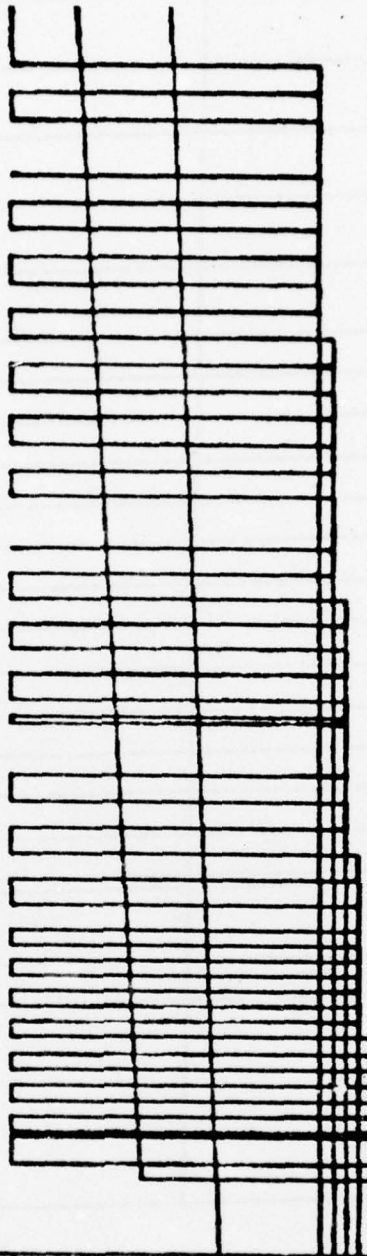
ENTER COMMAND

CH47FRB Root Loop
Ply 1 thru 50
View 4.
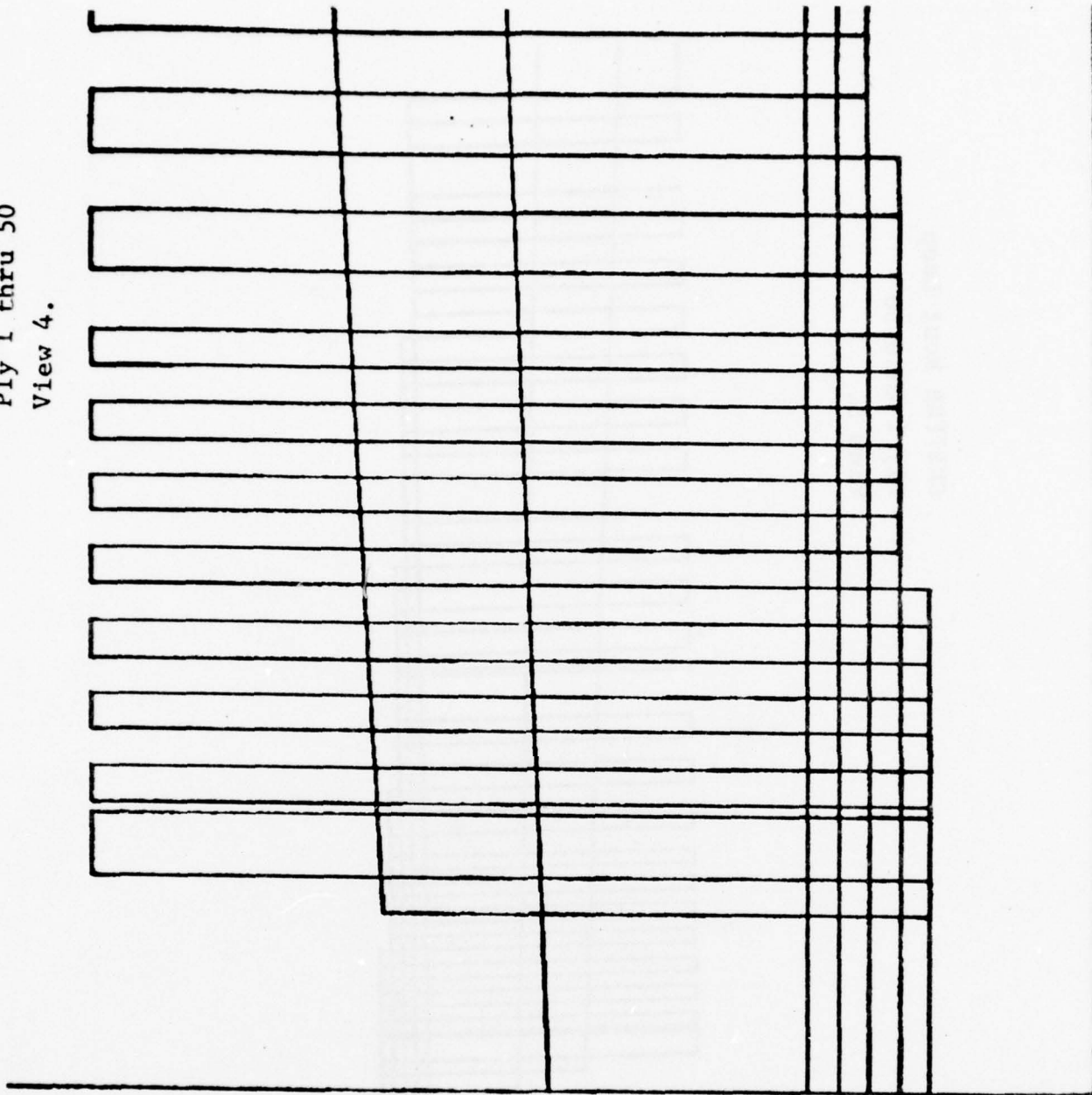
ENTER COMMAND

3. Control Tape Listings Produced by ATLSLI

    • IITRI Test Tape - First 50 Plies.

    • IITRI Test Tape - Ply 51 through Ply 144.

    • Original Boeing Tape - First 50 Plies.

    • Original Boeing Tape - Ply 51 through Ply 144.

3.1   IITRI Test Tape - First 50 Plies.

133

* * CH47FRB ROOT LOOP PLU 1 THRU 50 (IITRI GENERATED) * *   ATLAS CONTROL TAPE LIST 27-AUG-76   13:52:16   PAGE   1

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	1
!90														2
				0.000	-5.000	3.000	0.000	270.00	-0.000					3
														4
62														5
75														6
1														7
74					-3.042	0.000								8
														9
80					0.000				180.000					10
					5.000									11
														12
75					6.000	1.000								13
														14
								90.00						15
					5.184	3.000								16
														17
2														18
74					5.000	0.000								19
					2.826	0.009			-0.000					20
						0.014								21
80					0.000	0.019								22
														23
					-3.000	0.009								24
					-5.184	0.000								25
														26
75					3.826	1.014								27
								270.00						28
					-5.368	3.014								29
														30
3														31
74					-5.000	0.000								32
					-2.612	0.019								33
						0.024								34
80					0.000	0.028			180.000					35
														36
					5.000	0.019								37
					5.368	0.000								38
														39
75					-3.612	1.024								40
								90.00						41
					5.553	3.024								42
4														43
74					0.000	0.000								44
														45

134

* * CH47FRB ROOT LOOP PLU 1 THRU 50 (IITRI GENERATED) * *

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
	80			5.000	2.398	0.028							
						0.033							
				0.000		0.038			-0.000				
	75			-5.000	-5.553	0.028							
						-0.000							
				3.398		1.033							
						3.033							
				-5.737				270.00					
5	74			-5.000	-2.184	0.000							
						0.038							
						0.043							
	80			0.000		0.047							
				5.000	5.737	0.038			180.000				
						0.000							
	75			-3.184		1.043							
						3.043							
				5.921				90.00					
6	74			5.000	1.970	0.000							
						0.047							
						0.053							
	80			0.000		0.057							
				-5.000	-5.921	0.047			-0.000				
						0.000							
	75			2.970		1.053							
						3.053							
				-6.105				270.00					
7	74			-5.000	-1.755	0.000							
						0.057							
						0.063							
	80			0.000		0.066							
				5.000	6.105	0.057			180.000				
						0.000							
	75												

* * CH47FRB ROOT LOOP PLU 1 THRU 50 (IITRI GENERATED) * *

Seq	N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
93						-2.755	1.063							
94						6.289	3.063							
95									90.00					
96	8	74				0.000	0.000							
97						5.000	0.066							
98		80				1.541	0.073							
99														
100						0.000	0.076							
101														
102										-0.000				
103		75				-3.000	0.066							
104						-6.289	0.000							
105														
106						2.541	1.073							
107						-6.474	3.073							
108									270.00					
109	9	74				0.000	0.000							
110						-5.000	0.076							
111		80				-1.327	0.083							
112														
113						0.000	0.085							
114														
115										180.000				
116		75				5.000	0.076							
117						6.474	0.000							
118														
119						-2.327	1.083							
120						6.658	3.083							
121									90.00					
122	10	74				0.000	0.000							
123						5.000	0.085							
124		80				1.112	0.093							
125														
126						0.000	0.095							
127														
128										-0.000				
129		75				-5.000	0.085							
130						-6.658	0.000							
131														
132						2.112	1.093							
133						-6.842	3.093							
134									270.00					
135	11	74				0.000	0.000							
136						-5.000	0.095							
137						-0.898	0.103							
138														

* * CH47FRB ROOT LOOP PLU 1 THRU 50 (IITRI GENERATED) * *

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
			80	0.000	0.000	0.104			180.000				
					5.000	0.095							
					6.842	0.000							
			75	-1.898		1.103							
				7.026		3.103		90.00					
12			74		0.000	0.000							
			80		5.000	0.104							
					0.684	0.113			-0.000				
					0.000	0.114							
					-5.000	0.104							
					-7.026	0.000							
			75	1.684		1.113							
				-7.211		3.113		270.00					
13			74		-5.000	0.000							
			80		-0.470	0.114							
					0.000	0.123			180.000				
					5.000	0.123							
					7.211	0.114							
						0.000							
			75	-1.470		1.123							
				7.395		3.123		90.00					
14			74		5.000	0.000							
			80		0.255	0.123							
					0.000	0.133			-0.000				
					-5.000	0.133							
					-7.395	0.123							
						0.000							
			75	1.255		1.133							
						3.133							

N	G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	No.
15			-7.579	0.000		270.00						184
	74		-5.000	0.133								187
			-0.041	0.142								188
												189
	80		0.000	0.142								190
												191
							180.000					192
			5.000	0.133								193
			7.579	0.000								194
												195
	75		-1.041	1.142								196
				3.142								197
												198
			7.763	7.763		90.00						199
16			0.000	0.000								200
	74		5.000	0.142								201
			0.000	0.152								202
												203
	80						-174.780					204
												205
			-5.000	0.142			-0.000					206
			-7.763	0.000								207
	75											208
			8.763	4.142								209
				6.142								210
												211
			-7.947			270.00						212
17			0.000	0.000								213
	74		-5.000	0.152								214
			0.000	0.161								215
												216
	80						11.618					217
							180.000					218
			5.000	0.152								219
			7.947	0.000								220
	75		-8.947	7.142								221
												222
				9.142								223
												224
			8.132			90.00						225
18			0.000	0.000								226
	74		5.000	0.161								227
			0.000	0.171								228
												229
	80											230
							-162.048					231

138

** CH47FRB ROOT LOOP PLU 1 THRU 50 (IITRI GENERATED) **   ATLAS CONTROL TAPE LIST   27-AUG-76   13:52:16   PAGE   6

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
					-5.000	0.161			-0.000					232
					-8.132	0.000								233
			75											234
					9.132	10.142								235
						12.142								236
					-8.316			270.00						237
														238
19					-5.000	0.000								239
			74		0.000	0.171								240
						0.180								241
														242
									24.224					243
			80			0.171			180.000					244
					5.000	0.000								245
					8.316									246
														247
			75		-9.316	13.142								248
						15.142								249
					8.500			90.00						250
														251
20					-5.000	0.000								252
			74		0.000	0.180								253
						0.190								254
														255
									-149.566					256
			80			0.180			-0.000					257
					-5.000	0.000								258
					-8.500									259
														260
			75		9.500	16.142								261
						18.142								262
					-8.684			270.00						263
														264
21					-5.000	0.000								265
			74		0.000	0.190								266
						0.199								267
														268
									36.584					269
			80			0.190			180.000					270
					5.000	0.000								271
					8.684									272
														273
			75		-9.684	19.142								274
						21.142								275
					8.868			90.00						276
														277

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
22	74					0.000								278
					5.000	0.199								279
					0.000	0.209								280
	80								-137.325					281
														282
					-5.000	0.199								283
					-8.868	0.000								284
									-0.000					285
	75				9.868	22.142								286
						24.142								287
					-9.053									288
								270.00						289
														290
23	74					0.000								291
					-5.000	0.209								292
					0.000	0.218								293
	80								48.706					294
														295
					5.000	0.209								296
					9.053	0.000								297
									180.000					298
	75				-10.053	25.142								299
						27.142								300
					9.237									301
								90.00						302
														303
24	74					0.000								304
					5.000	0.218								305
					0.000	0.228								306
	80								-125.320					307
														308
					-5.000	0.218								309
					-9.237	0.000								310
									-0.000					311
	75				10.237	28.142								312
						30.142								313
					-9.421									314
								270.00						315
														316
25	74					0.000								317
					-5.000	0.228								318
					0.000	0.237								319
	80								60.596					320
														321
									180.000					322
														323

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			75		5.000	0.228								324
					9.421	0.000								325
														326
					-10.421	31.142								327
						33.142								328
					9.605			90.00						329
26						0.000								330
			74		5.000	0.237								331
					0.000	0.247								332
			80						-113.544					333
														334
									-0.000					335
					-5.000	0.237								336
					-9.605	0.000								337
			75											338
					10.605	34.142								339
						36.142								340
					-9.789			270.00						341
														342
27						0.000								343
			74		-5.000	0.247								344
					0.000	0.256								345
			80						72.261					346
														347
									180.000					348
					5.000	0.247								349
					9.789	0.000								350
			75											351
					-10.789	37.142								352
						39.142								353
					9.974			90.00						354
														355
28						0.000								356
			74		5.000	0.256								357
					0.000	0.266								358
			80						-101.989					359
														360
									-0.000					361
					-5.000	0.256								362
					-9.974	0.000								363
			75											364
					10.974	40.142								365
						42.142								366
					-10.158			270.00						367
														368

141

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
29						0.000								369
	74				-5.000	0.266								370
					0.000	0.275								371
									83.707					372
														373
	80								180.000					374
					5.000	0.266								375
					10.158	0.000								376
	75													377
					-11.158	43.142								378
						45.142								379
					10.342			90.00						380
														381
30						0.000								382
	74				5.000	0.275								383
					0.000	0.285								384
									-90.650					385
														386
	80								-0.000					387
					-5.000	0.275								388
					-10.342	0.000								389
	75													390
					11.342	46.142								391
						48.142								392
					-10.526			270.00						393
														394
31						0.000								395
	74				-5.000	0.285								396
					0.000	0.294								397
									94.941					398
														399
	80								180.000					400
					5.000	0.285								401
					10.526	0.000								402
	75													403
					-11.526	49.142								404
						51.142								405
					10.711			90.00						406
														407
32						0.000								408
	74				5.000	0.294								409
					0.000	0.304								410
									-79.521					411
														412
	80								-0.000					413
														414

142

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
				*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
415					-5.000	0.294							
416					-10.711	0.000							
417			75										
418					11.711	52.142							
419						54.142							
420					-10.895			270.00					

— 33 —

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
421			74			0.000							
422					-5.000	0.304							
423					0.000	0.313							
424													
425									105.967				
426			80										
427									180.000				
428					5.000	0.304							
429					10.895	0.000							
430			75										
431					-11.895	55.142							
432					11.079	57.142							
433								90.00					

— 34 —

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
434			74			0.000							
435					-5.000	0.313							
436					0.000	0.323							
437													
438									-68.596				
439			80										
440									-0.000				
441					5.000	0.313							
442					11.079	0.000							
443			75										
444					12.079	58.142							
445					-11.263	60.142							
446								270.00					

— 35 —

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
447			74			0.000							
448					-5.000	0.323							
449					0.000	0.332							
450													
451									116.792				
452			80										
453									180.000				
454					5.000	0.323							
455					11.263	0.000							
456			75										
457					-12.263	61.142							
458					11.447	63.142							
459								90.00					

143

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	**	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
36						0.000								460
	74													461
					5.000	0.332								462
					0.000	0.342			-57.869					463
		80												464
														465
					-5.000	0.332			-0.000					466
					-11.447	0.000								467
			75											468
					12.447	64.142								469
						66.142								470
								270.00						471
					-11.632	-11.632								472
37						0.000								473
	74													474
					-5.000	0.342								475
					0.000	0.351			127.422					476
		80												477
														478
					5.000	0.342			180.000					479
					11.632	0.000								480
			75											481
					-12.632	67.142								482
						69.142								483
								90.00						484
					11.816	11.816								485
38						0.000								486
	74													487
					5.000	0.351								488
					0.000	0.361			-47.335					489
		80												490
														491
					-5.000	0.351			-0.000					492
					-11.816	0.000								493
			75											494
					12.816	70.142								495
						72.142								496
								270.00						497
					-12.000	-12.000								498
39						0.000								499
	74													500
					-5.000	0.361								501
					0.000	0.370			137.861					502
		80												503
														504
						0.361			180.000					505

144

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	SEQ
					5.000	0.361								506
					12.000	0.000								507
			75											508
					-13.000	73.142								509
						75.142								510
					12.184			90.00						511
40						0.000								512
			74		5.000	0.370								513
					0.000	0.380								514
														515
			80						-36.989					516
														517
						0.000			-0.000					518
					-5.000	0.370								519
			75		-12.184	0.000								520
					13.184	76.142								521
						78.142								522
					-12.368									523
								270.00						524
41						0.000								525
			74		-5.000	0.380								526
					0.000	0.389								527
														528
			80						148.114					529
									180.000					530
														531
					5.000	0.380								532
			75		12.368	0.000								533
					-13.368	79.142								534
						81.142								535
					12.553									536
								90.00						537
42						0.000								538
			74		5.000	0.389								539
					0.000	0.399								540
														541
			80						-26.827					542
									-0.000					543
														544
					-5.000	0.389								545
			75		-12.553	0.000								546
					13.553	82.142								547
						84.142								548
					-12.737									549
								270.00						550

145

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
43			74			0.000	0.000							551
					-5.000	0.399								552
					0.000	0.408			158.188					553
			80											554
					5.000	0.399			180.000					555
					12.737	0.000								556
			75											557
					-13.737	85.142								558
					12.921	87.142								559
					12.921			90.00						560
														561
														562
														563
44			74			0.000	0.000							564
					5.000	0.408								565
					0.000	0.418			-16.842					566
			80											567
					-5.000	0.408			-0.000					568
					-12.921	0.000								569
			75											570
					13.921	88.142								571
					13.921	90.142								572
					-13.105			270.00						573
														574
														575
														576
45			74			0.000	0.000							577
					-5.000	0.418								578
					0.000	0.427			168.085					579
			80											580
					5.000	0.418			180.000					581
					13.105	0.000								582
			75											583
					-14.105	91.142								584
					13.289	93.142								585
					13.289			90.00						586
														587
														588
														589
46			74			0.000	0.000							590
					5.000	0.427								591
					0.000	0.437			-7.031					592
			80											593
									-0.000					594
														595
														596

146

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
	75			-5.000		0.427								597
				-13.289		0.000								598
				14.289		94.142								599
						96.142								600
				-13.474										601
								270.00						602
47	74					0.000	0.000							603
				-5.000		0.437								604
				0.000		0.446			177.811					605
	80								180.000					606
				5.000		0.437								607
				13.474		0.000								608
	75			-14.474		97.142								609
						99.142								610
				13.658										611
								90.00						612
														613
														614
														615
48	74					0.000	0.000							616
				5.000		0.446								617
				0.000		0.456								618
	80			-0.101		0.456			-0.000					619
				-5.000		0.446								620
				-13.658		0.000								621
	75			0.899		1.456								622
				-13.842		3.456								623
								270.00						624
														625
														626
														627
														628
49	74					0.000	0.000							629
				-5.000		0.456								630
				0.000		0.465								631
	80			0.285		0.465			180.000					632
				5.000		0.456								633
				13.842		0.000								634
	75			-0.715		1.465								635
				14.026		3.465								636
								90.00						637
														638
														639
														640
														641

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
50						0.000								642
74					5.000	0.465								643
					0.000	0.475								644
									-0.000					645
					-0.469	0.474								646
80					-5.000	0.465								647
					-14.026	0.000								648
75					0.531	1.474								649
						3.474								650
63														651
30														652
														653
														654
														655

3.2   IITRI Test Tape - Ply 51 through Ply 144.

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
***	**	**	***	********	********	********	********	********	********	*********	*********	*********	*********
1													
			62	0.000	0.000	3.000	0.000	180.00	0.000				
			75	-43.711	0.000	0.000							
51			74			0.000							
				-34.500		0.475							
				-29.500		0.484							
				-12.330									
				-19.330									
			64	-24.830				359.99	180.000				
			75										5.00
				-29.500		0.483							
				-30.183									
			80	-33.000		0.478							
			65 / 74	-34.500		0.475							
				-43.711		0.000							
			75	-44.711		1.000		180.00					
						3.000							
				-43.895									
52			74			0.000							
				-34.500		0.484							
				-29.500		0.494							
				-12.330									
				-19.330									
								359.99	0.000				
			64	-24.850									
			75										5.00
				-29.500									
				-30.368									
			80	-33.000		0.492							
			65			0.487							

150

** CH47FRB ROOT LOOP PLU 51 THRU 144 (IITRI GENERATED) **   ATLAS CONTROL TAPE LIST 27-AUG-76   13:53:21   PAGE   2

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
			74	-34.500		0.404								48
				-43.895		0.000								49
			75	-44.895		1.000								50
						3.000								51
														52
				-44.079				180.00						53
														54
														55
53			74	-34.500		0.000								56
				-29.500		0.494								57
				-12.330		0.503								58
				-19.330										59
														60
				-24.870										61
								359.99	180.000					62
														63
		4	64										5.00	64
			75	-29.500		0.502								65
				-30.552										66
														67
			80	-33.000		0.497								68
														69
			65	-34.500		0.494								70
			74	-44.079		-0.000								71
														72
														73
			75	-45.079		1.000								74
						3.000								75
														76
								180.00						77
				-44.263										78
														79
54			74	-34.500		0.000								80
				-29.500		0.503								81
				-12.330		0.513								82
				-19.330										83
														84
				-24.890										85
								359.99	0.000					86
														87
		4	64	-29.500		0.511								88
			75	-30.737										89
													5.00	90
			80	-33.000		0.506								91
														92
			65											93
														94
														95

151

N	C	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
96													
97			74	-34.500		0.503							
98				-44.263		0.000							
99													
100			75	-45.263		1.000							
101						3.000							
102								180.00					
103				-44.447									
55													
104			74	-34.500		0.000							
105				-34.500		0.513							
106				-29.500		0.522							
107				-12.330									
108				-19.330									
109								359.99	180.000				
110				-24.909									
111													
112													
113	4		64										5.00
114			75	-29.500		0.520							
115				-30.921									
116			80	-33.000		0.516							
117													
118			65										
119			74	-34.500		0.513							
120				-44.447		-0.000							
121													
122			75	-45.447		1.000							
123						3.000							
124								180.00					
125				-44.632									
126													
127													
56													
128			74	-34.500		0.000							
129				-34.500		0.522							
130				-29.500		0.532							
131				-12.330									
132				-19.330									
133								359.99	0.000				
134				-24.929									
135													
136													
137	4		64										5.00
138			75	-29.500		0.529							
139				-31.106									
140													
141			80	-33.000		0.525							
142			65										
143													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			74	-34.500		0.522								144
				-44.632		0.000								145
			75	-45.632		1.000								146
						3.000								147
														148
														149
				-44.816				180.00						150
														151
57			74	-34.500		0.000	0.000							152
				-29.500		0.532								153
				-12.330		0.541								154
				-19.330										155
														156
														157
				-24.949				359.99	180.000					158
														159
	4	64											5.00	160
														161
			75	-29.500		0.538								162
				-31.290										163
														164
			80	-33.000		0.535								165
														166
		65												167
			74	-34.500		0.532								168
				-44.816		-0.000								169
														170
			75	-45.816		1.000								171
						3.000								172
														173
														174
				-45.000				180.00						175
58			74	-34.500		0.000	0.000							176
				-29.500		0.541								177
				-12.330		0.551								178
				-19.330										179
														180
														181
				-24.969				359.99	0.000					182
														183
	4												5.00	184
			75	-29.500										185
														186
				-31.474		0.547								187
		80												188
				-33.000		0.544								189
		65												190
														191

** CH47FRB ROOT LOOP PLU 51 THRU 144 (IITRI GENERATED) **

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			74	-34.500		0.541								192
				-45.000		0.000								193
			75											194
				-46.000		1.000								195
						3.000								196
														197
				-45.423				180.00						198
														199
59						0.000								200
			74											201
				-45.000		0.009								202
				-34.500		0.551								203
				-29.500		0.560								204
				-12.330										205
				-19.330										206
								359.99	180.000					207
				-24.989										208
		4	64											209
			75										5.00	210
														211
			80	-29.500		0.555								212
				-32.177										213
			65	-33.000		0.554								214
			74											215
				-34.500		0.551								216
				-45.000		0.009								217
				-45.423		-0.000								218
			75	-46.423		1.000								219
						3.000								220
								180.00						221
				-45.846										222
														223
														224
														225
60						0.000								226
			74	-45.000		0.019								227
				-34.500		0.560								228
				-29.500		0.570								229
				-12.330										230
				-19.330										231
														232
								359.99	0.000					233
		4	64	-25.009										234
			75										5.00	235
														236
				-29.500		0.564								237
				-32.495										238
														239

* * CH47FRB ROOT LOOP PLU 51 THRU 144 (IITRI GENERATED) * *   ATLAS CONTROL TAPE LIST   27-AUG-76   13:53:21   PAGE   6

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			80	-33.000		0.563								240
														241
			65	-34.500		0.560								242
			74	-45.000		0.019								243
				-45.846		-0.000								244
														245
														246
			75	-46.846		1.000								247
						3.000								248
														249
								180.00						250
				-46.269										251
61														
			74	-45.000		0.000								252
				-34.500		0.028								253
				-29.500		0.570								254
				-12.330		0.579								255
				-19.330										256
														257
														258
								359.99	180.000					259
			64	-25.029										260
	4		75										5.00	261
														262
				-29.500		0.573								263
				-32.870										264
			80	-33.000		0.573								265
														266
			65	-34.500		0.570								267
			74	-45.000		0.028								268
				-46.269		-0.000								269
			75	-47.269		1.000								270
						3.000								271
								180.00						272
														273
				-46.692										274
														275
														276
														277
62														
			74	-45.000		0.000								278
				-34.500		0.038								279
				-29.500		0.579								280
				-12.330		0.589								281
				-19.330										282
														283
								359.99	0.000					284
			64	-25.048										285
														286
														287

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	Seq
4														288
			75	-29.500		0.582								289
				-33.000									5.00	290
			65											291
			74	-33.266		0.582								292
														293
			80	-34.500		0.579								294
				-45.000		0.038								295
				-46.692		-0.000								296
			75											297
				-47.692		1.000								298
						3.000								299
								180.00						300
				-47.115										301
														302
														303
63														304
			74	-45.000		0.000								305
				-34.500		0.047								306
				-29.500		0.589								307
				-12.330		0.598								308
				-19.330										309
									180.000					310
				-25.068				359.99						311
														312
														313
4			64											314
			75	-29.500		0.592							5.00	315
				-33.000		0.591								316
			65											317
			74	-33.673										318
														319
			80	-34.500		0.589								320
				-45.000		0.047								321
				-47.115		-0.000								322
			75											323
				-48.115		1.000								324
						3.000								325
								180.00						326
				-47.538										327
														328
														329
64														330
			74	-45.000		0.000								331
				-34.500		0.057								332
				-29.500		0.598								333
				-12.330		0.608								334
														335

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
336				-19.330									
337		64		-25.088				359.99	0.000				
338													5.00
339													
340	4		75										
341				-29.500									
342				-33.000		0.601							
343													
344				-34.085		0.599							
345													
346		65	74										
347				-34.500		0.598							
348		80		-45.000		0.057							
349				-47.538		-0.000							
350													
351													
352													
353		75		-48.538		1.000							
354													
355				-47.962		3.000		180.00					
356	65	74		-45.000		0.000							
357				-34.500		0.066							
358				-29.500		0.608							
359				-12.330		0.617							
360				-19.330									
361													
362				-25.108				359.99	180.000				
363													
364													5.00
365													
366	4		75										
367													
368				-29.500		0.611							
369				-33.000									
370													
371				-34.500		0.608							
372		65											
373			74										
374		80		-34.500		0.608							
375				-45.000		0.067							
376				-47.962		0.000							
377		75											
378				-48.962		1.000							
379						3.000							
380				-48.385				180.00					
381													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
384				-45.000		0.076							
385				-34.500		0.617							
386				-29.500		0.627							
387				-12.330									
388				-19.330									
389								359.99	0.000				
390			64	-25.128									
391	4		75										5.00
392				-29.500									
393				-33.000		0.620							
394			65										
395			74	-34.500		0.617							
396				-34.916		0.596							
397													
398			80	-45.000		0.076							
399				-48.385		-0.000							
400													
401			75	-49.385		1.000							
402						3.000							
403													
404								180.00					
405				-48.808									
406													
407													
408			67			0.000							
409			74	-45.000		0.085							
410				-34.500		0.627							
411				-29.500		0.636							
412				-12.330									
413				-19.330									
414								359.99	180.000				
415			64	-25.148									
416													
417													
418	4		75										5.00
419				-29.500		0.630							
420				-33.000									
421			65										
422			74	-34.500		0.627							
423				-35.334		0.584							
424													
425			80	-45.000		0.085							
426				-48.808		0.000							
427													
428													

158

** CH47FRB ROOT LOOP PLU 51 THRU 144 (IITRI GENERATED) **

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
					-49.231									433
68						0.000								434
			74	-45.000		0.095								435
				-34.500		0.636								436
				-29.500		0.646								437
				-12.330										438
				-19.330										439
														440
			64	-25.168				359.99	0.000					441
														442
	4		75										5.00	443
														444
														445
				-29.500		0.639								446
				-33.000										447
														448
			65 74	-34.500		0.636								449
				-35.753		0.572								450
														451
			80	-45.000		0.095								452
				-49.231		-0.000								453
														454
			75	-50.231		1.000								455
						3.000								456
														457
				-49.654				180.00						458
														459
69						0.000								460
			74	-45.000		0.104								461
				-34.500		0.646								462
				-29.500		0.655								463
				-12.330										464
				-19.330										465
														466
			64	-25.187				359.99	180.000					467
														468
	4		75										5.00	469
														470
														471
				-29.500		0.649								472
				-33.000										473
														474
			65 74	-34.500		0.646								475
				-36.172		0.560								476
														477
			80	-45.000		0.104								478
				-49.654		0.000								479
														480

159

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
481	75			-50.654		1.000							
482													
483													
484				-50.077		3.000		180.00					
485													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
486	70 74					0.000							
487				-45.000		0.114							
488				-34.500		0.655							
489				-29.500		0.665							
490				-12.330									
491				-19.330									
492													
493	64			-25.207				359.99	0.000				
494													
495													
496	4 75												5.00
497				-29.500									
498				-33.000		0.658							
499													
500	65 74			-34.500		0.655							
501				-36.592		0.548							
502													
503	80			-45.000		0.114							
504				-50.077		-0.000							
505													
506	75			-51.077		1.000							
507						3.000							
508													
509				-50.500		0.000		180.00					
510													
511													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
512	71 74					0.000							
513				-45.000		0.123							
514				-34.500		0.665							
515				-29.500		0.674							
516				-12.330									
517				-19.330									
518													
519	64			-25.227				359.99	180.000				
520													
521													
522	4 75												5.00
523				-29.500									
524				-33.000		0.668							
525													
526	65 74			-34.500		0.665							
527													
528													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			80	-37.012		0.535								529
				-45.000		0.123								530
				-50.500		-0.000								531
			75											532
				-51.500		1.000								533
						3.000								534
														535
				-55.000				180.00						536
														537
72														
		74		-50.500		0.000								538
				-45.000		0.009								539
				-34.500		0.133								540
				-29.500		0.674								541
				-12.330		0.684								542
				-19.330										543
														544
														545
				-25.247				359.99	0.000					546
														547
	4		64									5.00		548
			75	-29.500										549
				-33.000		0.577								550
														551
														552
			65 74											553
				-34.500		0.674								554
				-41.558		0.311								555
														556
			80											557
				-45.000		0.133								558
				-50.500		0.009								559
				-55.000		-0.000								560
														561
			75	-56.000		1.000								562
						3.000								563
														564
				-55.625				180.00						565
73														
		74		-55.000		0.000								566
				-50.500		0.009								567
				-45.000		0.019								568
				-34.500		0.142								569
				-29.500		0.684								570
				-12.330		0.693								571
				-19.330										572
														573
														574
				-25.267				359.99	180.000					575
														576

161

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
577	4		64										5.00
578			75	-29.500									
579				-33.000		0.687							
580			65	-34.500		0.684							
581			74	-42.490		0.272							
582			80	-45.000		0.142							
583				-50.500		0.019							
584				-55.000		0.009							
585				-55.625		-0.000							
586			75	-56.625		1.000							
587						3.000							
588				-56.250				180.00					
589													
590													
591													
592													
593													
594													
595													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
596			74	-55.000		0.000							
597				-50.500		0.019							
598				-45.000		0.028							
599				-34.500		0.152							
600				-29.500		0.693							
601				-12.330		0.703							
602				-19.330									
603													
604				-25.287				359.99	0.000				
605	4		64										5.00
606			75	-29.500		0.696							
607				-33.000									
608			65	-34.500		0.693							
609			74	-42.990		0.256							
610			80	-45.000		0.152							
611				-50.500		0.028							
612				-55.000		0.019							
613				-56.250		-0.000							
614			75	-57.250		1.000							
615						3.000							
616				-56.875				180.00					
617													
618													
619													
620													
621													
622													
623													
624													
625													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	Seq
75						0.000								626
			74	-55.000		0.028								627
				-50.500		0.038								628
				-45.000		0.161								629
				-34.500		0.703								630
				-29.500		0.712								631
				-12.330										632
				-19.330										633
														634
				-25.307				359.99						635
									180.000					636
														637
	4		64										5.00	638
			75											639
				-29.500		0.706								640
				-33.000										641
			65											642
			74											643
				-34.500		0.703								644
				-43.561		0.236								645
			80											646
				-45.000		0.161								647
				-50.500		0.038								648
				-55.000		0.028								649
				-56.875		-0.000								650
				-57.875		1.000								651
						3.000								652
			75											653
								180.00						654
				-57.500										655
76						0.000								656
			74	-55.000		0.038								657
				-50.500		0.047								658
				-45.000		0.171								659
				-34.500		0.712								660
				-29.500		0.722								661
				-12.330										662
				-19.330										663
														664
				-25.326				359.99						665
									0.000					666
														667
	4		64										5.00	668
			75											669
				-29.500		0.715								670
				-33.000										671
			65											672
			74											673

163

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
***	**	**	***	********	********	********	********	********	********	*********	*********	*********	*********	
				-34.500		0.712								674
			80	-44.157		0.214								675
														676
				-45.000		0.171								677
				-50.500		0.048								678
				-55.000		0.038								679
				-57.500		0.000								680
														681
			75	-58.500		1.000								682
						3.000								683
				-58.125				180.00						684
														685
77														
			74			0.000								686
				-55.000		0.047								687
				-50.500		0.057								688
				-45.000		0.180								689
				-34.500		0.722								690
				-29.500		0.731								691
				-12.330										692
				-19.330										693
								359.99	180.000					694
				-25.346										695
	4		64										5.00	696
			75											697
				-29.500		0.725								698
				-33.000										699
														700
			65	-34.500		0.722								701
			74	-44.763		0.193								702
														703
			80	-45.000		0.180								704
				-50.500		0.057								705
				-55.000		0.047								706
				-58.125		-0.000								707
														708
			75	-59.125		1.000								709
						3.000								710
														711
				-58.750				180.00						712
														713
														714
														715
78														
			74			0.000								716
				-55.000		0.057								717
				-50.500		0.066								718
				-45.000		0.190								719
				-34.500		0.731								720
														721

164

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
722				-29.500		0.741							
723				-12.330									
724				-19.330									
725													
726				-25.366				359.99	0.000				
727													
728													5.00
729	4												
730	75			-29.500									
731				-33.000		0.734							
732	65												
733	74												
734				-34.500		0.731							
735				-45.000		0.190							
736				-45.376		0.182							
737	80												
738				-50.500		0.066							
739				-55.000		0.057							
740				-58.750		0.000							
741	75												
742				-59.750		1.000							
743						3.000							
744								180.00					
745				-59.375									
746	79					0.000							
747	74			-55.000		0.066							
748				-50.500		0.076							
749				-45.000		0.199							
750				-34.500		0.741							
751				-29.500		0.750							
752				-12.330									
753				-19.330									
754													
755				-25.386				359.99	180.000				
756													
757													5.00
758													
759	4												
760	64			-29.500		0.744							
761	75			-33.000									
762	65												
763	74												
764				-34.500		0.741							
765				-45.000		0.199							
766				-45.992		0.177							
767	80												
768				-50.500		0.076							
769				-55.000		0.066							
770				-59.375		-0.000							

165

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
722				-29.500		0.741							
723				-12.330									
724				-19.330									
725								359.99	0.000				5.00
726	4		64	-25.366									
727													
728													
729			75	-29.500									
730				-33.000		0.734							
731													
732													
733		65	74	-34.500		0.731							
734				-45.000		0.190							
735				-45.376		0.182							
736													
737													
738			80	-50.500		0.066							
739				-55.000		0.057							
740				-58.750		0.000							
741													
742			75	-59.750		1.000							
743						3.000							
744				-59.375				180.00					
745													
746				-55.000		0.000							
747				-50.500		0.066							
748				-45.000		0.076							
749				-34.500		0.199							
750				-29.500		0.741							
751				-12.330		0.750							
752				-19.330									
753													
754				-25.386				359.99	180.000				5.00
755													
756	4		64	-29.500									
757			75	-33.000		0.744							
758													
759													
760		65	74	-34.500		0.741							
761				-45.000		0.199							
762				-45.992		0.177							
763													
764			80	-50.500		0.076							
765				-55.000		0.066							
766				-59.375		-0.000							
767													
768													
769													
770													

79

N G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	Seq
**** ** ***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
75	-60.375		1.000								771
			3.000		180.00						772
											773
											774
	-60.000										775
80			0.000								776
74	-55.000		0.076								777
	-50.500		0.085								778
	-45.000		0.209								779
	-34.500		0.750								780
	-29.500		0.760								781
	-12.330										782
	-19.330										783
64					359.99	0.000					784
	-25.406										785
											786
4										5.00	787
75											788
	-29.500		0.753								789
65	-33.000										790
74											791
	-34.500		0.750								792
	-45.000		0.209								793
	-46.610		0.173								794
											795
											796
80	-50.500		0.085								797
	-55.000		0.076								798
	-60.000		0.000								799
75	-61.000		1.000								800
			3.000		180.00						801
											802
											803
											804
	-60.625										805
81			0.000								806
74	-60.000		0.009								807
	-55.000		0.085								808
	-50.500		0.095								809
	-45.000		0.218								810
	-34.500		0.760								811
	-29.500		0.769								812
	-12.330										813
	-19.330										814
					359.99	180.000					815
64	-25.426										816
											817
											818

166

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	819
4	75			-29.500										820
				-33.000		0.763							5.00	821
														822
	65													823
	74			-34.500		0.760								824
				-45.000		0.218								825
				-47.601		0.160								826
														827
	80			-50.500		0.095								828
				-55.000		0.085								829
				-60.000		0.009								830
				-60.625		-0.000								831
														832
	75			-61.625		1.000								833
						3.000								834
				-61.250				180.00						835
														836
														837
82														838
	74			-60.000		0.000								839
				-55.000		0.019								840
				-50.500		0.095								841
				-45.000		0.104								842
				-34.500		0.228								843
				-29.500		0.769								844
				-12.330		0.779								845
				-19.330										846
														847
				-25.446				359.99	0.000					848
														849
4	64												5.00	850
	75			-29.500										851
				-33.000		0.772								852
														853
	65													854
	74			-34.500		0.769								855
				-45.000		0.228								856
				-48.083		0.159								857
														858
														859
	80			-50.500		0.104								860
				-55.000		0.095								861
				-60.000		0.019								862
				-61.250		-0.000								863
	75													864
				-62.250		1.000								865
						3.000								866
														867

167

* * CH47FRB ROOT LOOP PLU 51 THRU 144 (IITRI GENERATED) * *   ATLAS CONTROL TAPE LIST   27-AUG-76   13:53:21   PAGE 19

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
868			74	-61.875		0.000		180.00	180.000				
869													
870				-60.000		0.028							
871				-55.000		0.104							
872				-50.500		0.114							
873				-45.000		0.237							
874				-34.500		0.779							
875				-29.500		0.788							
876				-12.330									
877				-19.330									
878													
879													
880			64	-25.465				359.99					
881													
882													
883	4		75										5.00
884				-29.500		0.782							
885			65	-33.000									
886			74	-34.500		0.779							
887				-45.000		0.237							
888				-48.644		0.156							
889			80	-50.500		0.114							
890				-55.000		0.104							
891				-60.000		0.028							
892				-61.875		-0.000							
893			75	-62.875		1.000							
894				-62.500		3.000							
895													
896													
897													
898													
899													
900								180.00					
901													
902			74	-60.000		0.000							
903				-55.000		0.038							
904				-50.500		0.114							
905				-45.000		0.123							
906				-34.500		0.247							
907				-29.500		0.788							
908				-12.330		0.798							
909				-19.330									
910													
911													
912	4		64	-25.485				359.99	0.000				
913													
914													5.00
915													

83

84

168

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			75	-29.500										916
				-33.000		0.791								917
														918
														919
														920
		65	74	-34.500		0.788								921
				-45.000		0.247								922
				-49.234		0.152								923
			80											924
				-50.500		0.123								925
				-55.000		0.114								926
				-60.000		0.038								927
				-62.500		-0.000								928
			75											929
				-63.500		1.000								930
						3.000								931
								180.00						932
				-63.125										933
85			74			0.000								934
				-60.000		0.047								935
				-55.000		0.123								936
				-50.500		0.133								937
				-45.000		0.256								938
				-34.500		0.798								939
				-29.500		0.807								940
				-12.330										941
				-19.330										942
								359.99	180.000					943
	4		64	-25.505										944
			75											945
													5.00	946
														947
														948
				-29.500		0.801								949
				-33.000										950
		65	74											951
				-34.500		0.798								952
				-45.000		0.256								953
				-49.837		0.148								954
			80											955
				-50.500		0.133								956
				-55.000		0.123								957
				-60.000		0.047								958
				-63.125		-0.000								959
			75											960
				-64.125		1.000								961
						3.000								962
								180.00						963
														964

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
				******	******	******	******	******	******	********	********	********	********
86			74	-63.750		0.000							
				-60.000		0.057							
				-55.000		0.133							
				-50.500		0.142							
				-45.000		0.266							
				-34.500		0.807							
				-29.500		0.817							
				-12.330									
				-19.330									
		4	64	-25.525				359.99	0.000				
			75	-29.500									
				-33.000		0.810							5.00
			65	-34.500		0.807							
			74	-45.000		0.266							
				-50.447		0.144							
			80	-50.500		0.142							
				-55.000		0.133							
				-60.000		0.057							
				-63.750		-0.000							
			75	-64.750		1.000							
				-64.375		3.000			180.00					
87			74	-60.000		0.000							
				-55.000		0.066							
				-50.500		0.142							
				-45.000		0.152							
				-34.500		0.275							
				-29.500		0.817							
				-12.330		0.826							
				-19.330				359.99	180.000				

965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			65	-29.500		0.820								1013
			74	-33.000										1014
				-34.500		0.817								1015
				-45.000		0.275								1016
				-50.500		0.152								1017
				-51.062		0.151								1018
			80	-55.000		0.142								1019
				-60.000		0.066								1020
				-64.375		0.000								1021
			75	-65.375		1.000								1022
				-65.000		3.000		180.00						1023
														1024
														1025
														1026
														1027
														1028
														1029
88				-65.000		0.000								1030
			74	-60.000		0.076								1031
				-55.000		0.152								1032
				-50.500		0.161								1033
				-45.000		0.285								1034
				-34.500		0.826								1035
				-29.500		0.836								1036
				-12.330										1037
				-19.330										1038
								359.99	0.000					1039
				-25.565										1040
	4		64										5.00	1041
			75	-29.500		0.829								1042
			65	-33.000										1043
			74	-34.500		0.826								1044
				-45.000		0.285								1045
				-50.500		0.161								1046
				-51.679		0.159								1047
			80	-55.000		0.152								1048
				-60.000		0.076								1049
			75	-65.000		-0.000								1050

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
89			74			0.000								1062
				-65.000		0.009								1063
				-60.000		0.085								1064
				-55.000		0.161								1065
				-50.500		0.171								1066
				-45.000		0.294								1067
				-34.500		0.836								1068
				-29.500		0.845								1069
				-19.330										1070
				-12.330										1071
														1072
		4	64	-25.585				359.99	180.000				5.00	1073
														1074
														1075
			73	-29.500		0.839								1076
				-33.000										1077
														1078
			65											1079
			74	-34.500		0.836								1080
				-45.000		0.294								1081
				-50.500		0.171								1082
				-52.639		0.166								1083
														1084
														1085
			80	-55.000		0.161								1086
				-60.000		0.085								1087
				-65.000		0.009								1088
				-65.455		-0.000								1089
														1090
			75	-66.455		1.000								1091
				-65.909		3.000		180.00						1092
														1093
														1094
														1095
90			74	-65.000		0.000								1096
				-60.000		0.019								1097
				-55.000		0.095								1098
				-50.500		0.171								1099
				-45.000		0.180								1100
				-34.500		0.304								1101
				-29.500		0.845								1102
				-12.330		0.855								1103
				-19.330										1104
														1105
														1106
			64	-25.604				359.99	0.000					1107
														1108
														1109

172

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	********	********	********	********	********	********	********	********	********	********
1110	4												5.00
1111													
1112			75	-29.500									
1113				-33.000		0.848							
1114			65										
1115			74										
1116				-34.500		0.845							
1117				-45.000		0.304							
1118				-50.500		0.180							
1119				-52.927		0.175							
1120			80										
1121				-55.000		0.171							
1122				-60.000		0.095							
1123				-65.000		0.019							
1124				-65.909		-0.000							
1125			75										
1126				-66.909		1.000							
1127						3.000							
1128				-66.364				180.00					
1129													
1130			91			0.000							
1131			74										
1132				-65.000		0.028							
1133				-60.000		0.104							
1134				-55.000		0.180							
1135				-50.500		0.190							
1136				-45.000		0.313							
1137				-34.500		0.855							
1138				-29.500		0.864							
1139				-12.330									
1140				-19.330									
1141			64					359.99	180.000				
1142													
1143				-25.624									
1144	4		75										5.00
1145													
1146			65	-29.500									
1147			74	-33.000		0.858							
1148			65										
1149			74										
1150				-34.500		0.855							
1151				-45.000		0.313							
1152				-50.500		0.190							
1153				-53.293		0.184							
1154			80										
1155				-55.000		0.180							
1156				-60.000		0.104							
1157				-65.000		0.028							
1158				-66.364		-0.000							

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	**	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
			75	-67.364		1.000								1159
						3.000								1160
				-66.818				180.00						1161
														1162
														1163
92						0.000								1164
			74											1165
				-65.000		0.038								1166
				-60.000		0.114								1167
				-55.000		0.190								1168
				-50.500		0.199								1169
				-45.000		0.323								1170
				-34.500		0.864								1171
				-29.500		0.874								1172
				-12.330										1173
				-19.330										1174
														1175
			64	-25.644				359.99	0.000					1176
	4													1177
			75										5.00	1178
				-29.500		0.867								1179
				-33.000										1180
			65											1181
			74											1182
				-34.500		0.864								1183
				-45.000		0.323								1184
				-50.500		0.199								1185
				-53.696		0.193								1186
			80											1187
				-55.000		0.190								1188
				-60.000		0.114								1189
				-65.000		0.038								1190
				-66.818		-0.000								1191
			75											1192
				-67.818		1.000								1193
						3.000								1194
				-67.273				180.00						1195
														1196
93						0.000								1197
			74											1198
				-65.000		0.047								1199
				-60.000		0.123								1200
				-55.000		0.199								1201
				-50.500		0.209								1202
				-45.000		0.332								1203
				-34.500		0.874								1204
				-29.500		0.883								1205
														1206

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
				-12.330										1207
				-19.330					180.000					1208
														1209
	64			-25.664				359.99						1210
														1211
													5.00	1212
4	75			-29.500										1213
				-33.000		0.877								1214
														1215
	65			-34.500		0.874								1216
	74			-45.000		0.332								1217
				-50.500		0.209								1218
				-54.117		0.201								1219
														1220
	80			-55.000		0.199								1221
				-60.000		0.123								1222
				-65.000		0.047								1223
				-67.273		-0.000								1224
														1225
	75			-68.273		1.000								1226
						3.000								1227
								180.00						1228
				-67.727										1229
														1230
														1231
94						0.000			0.000					1232
	74			-65.000		0.057								1233
				-60.000		0.133								1234
				-55.000		0.209								1235
				-50.500		0.218								1236
				-45.000		0.342								1237
				-34.500		0.342								1238
				-29.500		0.883								1239
				-12.330		0.893								1240
				-19.330										1241
														1242
4	64			-25.684				359.99						1243
														1244
													5.00	1245
	75			-29.500										1246
				-33.000		0.886								1247
														1248
	65			-34.500		0.883								1249
	74			-45.000		0.342								1250
				-50.500		0.218								1251
				-54.549		0.210								1252
														1253
														1254
														1255

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			80	-55.000		0.209								1256
				-60.000		0.133								1257
				-65.000		0.057								1258
				-67.727		-0.000								1259
			75	-68.727		1.000								1260
						3.000								1261
														1262
				-68.182				180.00						1263
														1264
														1265
95														
			74			0.000								1266
				-65.000		0.066								1267
				-60.000		0.142								1268
				-55.000		0.218								1269
				-50.500		0.228								1270
				-45.000		0.351								1271
				-34.500		0.893								1272
				-29.500		0.902								1273
				-12.330										1274
				-19.330										1275
														1276
				-25.704				359.99	180.000					1277
														1278
													5.00	1279
4			64											1280
			75	-29.500										1281
				-33.000		0.896								1282
			65											1283
			74											1284
				-34.500		0.893								1285
				-45.000		0.351								1286
				-50.500		0.228								1287
				-54.986		0.219								1288
														1289
			80	-55.000		0.218								1290
				-60.000		0.142								1291
				-65.000		0.066								1292
				-68.182		-0.000								1293
			75	-69.182		1.000								1294
						3.000								1295
														1296
				-68.636				180.00						1297
														1298
														1299
96														
			74			0.000								1300
														1301
				-65.000		0.076								1302
				-60.000		0.152								1303

176

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	***	**	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
1304				-55.000		0.228							
1305				-50.500		0.237							
1306				-45.000		0.361							
1307				-34.500		0.902							
1308				-29.500		0.912							
1309				-12.330									
1310				-19.330									
1311													
1312													
1313			64	-25.723				359.99	0.000				
1314	4		75										5.00
1315				-29.500		0.905							
1316			65	-33.000									
1317			74										
1318				-34.500		0.902							
1319				-45.000		0.361							
1320				-50.500		0.237							
1321				-55.000		0.228							
1322				-55.428		0.221							
1323													
1324			80	-60.000		0.152							
1325				-65.000		0.076							
1326				-68.636		0.000							
1327			75	-69.636		1.000							
1328						3.000							
1329													
1330				-69.091				180.00					
1331													
1332													
1333													
1334			97			0.000							
1335			74	-65.000		0.085							
1336				-60.000		0.161							
1337				-55.000		0.237							
1338				-50.500		0.247							
1339				-45.000		0.370							
1340				-34.500		0.912							
1341				-29.500		0.921							
1342				-12.330									
1343				-19.330									
1344			64	-25.743				359.99	180.000				
1345	4		75										5.00
1346				-29.500									
1347			65	-33.000		0.915							
1348													
1349													
1350													
1351													
1352													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
			74	-34.500		0.912							
				-45.000		0.370							
				-50.500		0.247							
				-55.000		0.237							
				-55.872		0.224							
			80	-60.000		0.161							
				-65.000		0.085							
				-69.091		-0.000							
			75	-70.091		1.000							
						3.000							
				-69.545				180.00					
98						0.000							
			74	-65.000		0.095							
				-60.000		0.171							
				-55.000		0.247							
				-50.500		0.256							
				-45.500		0.380							
				-34.500		0.921							
				-29.500		0.931							
				-12.330									
				-19.330				359.99	0.000				
4			64	-25.763									
			75	-29.500		0.924							5.00
				-33.000									
			65	-34.500		0.921							
			74	-45.000		0.380							
				-50.500		0.256							
				-55.000		0.247							
				-56.318		0.227							
			80	-60.000		0.171							
				-65.000		0.095							
				-69.545		0.000							
			75	-70.545		1.000							
						3.000							
				-70.000				180.00					

Line numbers: 1353, 1354, 1355, 1356, 1357, 1358, 1359, 1360, 1361, 1362, 1363, 1364, 1365, 1366, 1367, 1368, 1369, 1370, 1371, 1372, 1373, 1374, 1375, 1376, 1377, 1378, 1379, 1380, 1381, 1382, 1383, 1384, 1385, 1386, 1387, 1388, 1389, 1390, 1391, 1392, 1393, 1394, 1395, 1396, 1397, 1398, 1399, 1400, 1401

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
99			74			0.000								1402
				-65.000		0.104								1403
				-60.000		0.180								1404
				-55.000		0.256								1405
				-50.500		0.266								1407
				-45.000		0.389								1408
				-34.500		0.931								1409
				-29.500		0.940								1410
				-12.330										1411
				-19.330										1412
			64	-25.783				359.99	180.000					1413
		4												1414
			75	-29.500									5.00	1415
				-33.000		0.934								1416
		65												1417
			74	-34.500		0.931								1418
				-45.000		0.389								1419
				-50.500		0.266								1420
				-55.000		0.256								1421
				-56.766		0.230								1422
			80	-60.000		0.180								1423
				-65.000		0.104								1424
				-70.000		-0.000								1425
			75	-71.000		1.000		180.00						1426
						3.000								1427
				-70.636										1428
														1429
														1430
														1431
														1432
														1433
														1434
														1435
100			74			0.000								1436
				-70.000		0.069								1437
				-65.000		0.114								1438
				-60.000		0.190								1439
				-55.000		0.266								1440
				-50.500		0.275								1441
				-45.000		0.399								1442
				-34.500		0.940								1443
				-29.500		0.950								1444
				-12.330										1445
				-19.330										1446
														1447
				-25.803				359.99	0.000					1448
														1449

179

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	********	********	********	********	********	********	********	********	********	********
4	64												
	75												5.00
				-29.500									
				-33.000		0.943							
	65	74		-34.500		0.940							
				-45.000		0.399							
				-50.500		0.275							
				-55.000		0.266							
				-57.910		0.222							
	80			-60.000		0.190							
				-65.000		0.114							
				-70.000		0.010							
				-70.636		0.000							
	75			-71.636		1.000							
						3.000							
				-71.273				180.00					

1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
101	74												
				-70.000		0.000							
				-65.000		0.019							
				-60.000		0.123							
				-55.000		0.199							
				-50.500		0.275							
				-45.000		0.285							
				-34.500		0.408							
				-29.500		0.950							
				-12.330		0.959							
				-19.330				359.99	180.000				
4	64			-25.823									
	75												5.00
				-29.500									
65	74			-33.000		0.953							
				-34.500		0.950							
				-45.000		0.408							
				-50.500		0.285							
				-55.000		0.275							
80				-58.360		0.224							

1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498

* * CH47FRB ROOT LOOP PLU 51 THRU 144 (IITRI GENERATED) * * ATLAS CONTROL TAPE LIST 27-AUG-76 13:53:21 PAGE 32

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
				-60.000		0.199								1499
				-65.000		0.123								1500
				-70.000		0.019								1501
				-71.273		-0.000								1502
			75											1503
				-72.273		1.000								1504
						3.000								1505
								180.00						1506
				-71.909										1507
102			74	-70.000		0.000								1508
				-65.000		0.028								1509
				-60.000		0.133								1510
				-55.000		0.209								1511
				-50.500		0.285								1512
				-45.000		0.294								1513
				-34.500		0.418								1514
				-29.500		0.959								1515
				-12.330		0.969								1516
				-19.330										1517
														1518
	4		64	-25.843		0.962		359.99	0.000					1519
			75											1520
														1521
														1522
													5.00	1523
														1524
			65	-29.500										1525
			74	-33.000										1526
				-34.500		0.959								1527
				-45.000		0.418								1528
				-50.500		0.294								1529
				-55.000		0.285								1530
				-58.907		0.226								1531
														1532
			80	-60.000		0.269								1533
				-65.000		0.133								1534
				-70.000		0.029								1535
				-71.909		0.000								1536
														1537
			75	-72.909		1.000								1538
						3.000		180.00						1539
														1540
				-72.545										1541
														1542
103			74	-70.000		0.000								1543
						0.038								1544

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	********	********	********	********	********	********	********	********	********	********	
				-65.000		0.142								1547
				-60.000		0.218								1548
				-55.000		0.294								1549
				-50.500		0.304								1550
				-45.000		0.427								1551
				-34.500		0.969								1552
				-29.500		0.978								1553
				-12.330										1554
				-19.330										1555
														1556
64				-25.862				359.99	180.000				5.00	1557
4														1558
75				-29.500		0.972								1559
				-33.000										1560
65														1561
74				-34.500		0.969								1562
				-45.000		0.427								1563
				-50.500		0.304								1564
				-55.000		0.294								1565
				-59.493		0.226								1566
				-60.000		0.218								1567
				-65.000		0.142								1568
80				-70.000		0.038								1569
				-72.545		-0.000								1570
75				-73.545		1.000								1571
						3.000		180.00						1572
				-73.182										1573
														1574
														1575
														1576
														1577
														1578
														1579
104				-70.000		0.000								1580
74				-65.000		0.047								1581
				-60.000		0.152								1582
				-55.000		0.228								1583
				-50.500		0.304								1584
				-45.000		0.313								1585
				-34.500		0.437								1586
				-29.500		0.978								1587
				-12.330		0.988								1588
				-19.330										1589
														1590
														1591
64				-25.882				359.99	0.000				5.00	1592
4														1593
														1594
														1595

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			75											1596
				-29.500										1597
				-33.000		0.981								1598
														1599
			65											1600
			74											1601
				-34.500		0.978								1602
				-45.000		0.437								1603
				-50.500		0.313								1604
				-55.000		0.304								1605
				-60.000		0.228								1606
				-60.098		0.227								1607
			80											1608
				-65.000		0.152								1609
				-70.000		0.047								1610
				-73.182		0.000								1611
			75											1612
				-74.182		1.000								1613
						3.000								1614
				-73.818				180.00						1615
105						0.000								1616
			74											1617
				-70.000		0.057								1618
				-65.000		0.161								1619
				-60.000		0.237								1620
				-55.000		0.313								1621
				-50.500		0.323								1622
				-45.000		0.446								1623
				-34.500		0.988								1624
				-29.500		0.997								1625
				-12.330										1626
				-19.330										1627
				-25.902				359.99	180.000					1628
														1629
			64											1630
4			75										5.00	1631
														1632
				-29.500										1633
				-33.000		0.991								1634
			65											1635
			74											1636
				-34.500		0.938								1637
				-45.000		0.446								1638
				-50.500		0.323								1639
				-55.000		0.313								1640
				-60.000		0.237								1641
				-60.712		0.227								1642
			80											1643
				-65.000		0.161								1644

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	SEQ
				-70.000		0.057								1645
			75	-73.818		-0.000								1646
														1647
				-74.818		1.000								1648
						3.000								1649
								180.00						1650
				-74.455										1651
106			74			0.000								1652
				-70.000		0.066								1653
				-65.000		0.171								1654
				-60.000		0.247								1655
				-55.500		0.323								1656
				-50.500		0.332								1657
				-45.000		0.456								1658
				-34.500		0.997								1659
				-29.500		1.007								1660
				-12.330										1661
				-19.330										1662
														1663
4			64	-25.922				359.99	0.000					1664
			75											1665
				-29.500		1.000							5.00	1666
				-33.000										1667
			65	-34.500		0.997								1668
			74	-45.000		0.456								1669
				-50.500		0.332								1670
				-55.000		0.323								1671
				-60.000		0.247								1672
				-61.333		0.227								1673
				-65.000		0.171								1674
			80	-70.000		0.066								1675
				-74.455		-0.000								1676
														1677
			75	-75.455		1.000								1678
						3.000								1679
								180.00						1680
				-75.091										1681
107			74			0.000								1688
				-70.000		0.076								1689
				-65.000		0.180								1690
				-60.000		0.256								1691

184

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
				-55.000		0.332								1693
				-50.500		0.342								1694
				-45.000		0.465								1695
				-34.500		1.007								1696
				-29.500		1.016								1697
														1698
														1699
64				-25.942				359.99	180.000					1700
75	4												5.00	
				-29.500		1.010								1706
				-33.000										1707
65				-34.500		1.007								1708
74				-45.000		0.465								1709
				-50.500		0.342								1710
				-55.000		0.332								1711
				-60.000		0.256								1712
				-61.957		0.227								1713
80				-65.000		0.180								1714
				-70.000		0.076								1715
				-75.091		0.000								1716
75				-76.091		1.000		180.00						1717
						3.000								1718
				-75.727										1719
108						0.000								1724
74				-70.000		0.000								1725
				-65.000		0.085								1726
				-60.000		0.190								1727
				-55.000		0.266								1728
				-50.500		0.342								1729
				-45.000		0.351								1730
				-34.500		0.475								1731
				-29.500		1.016								1732
				-12.330		1.026								1733
				-19.330										1734
64				-25.962				359.99	0.000					1740
75	4			-29.500									5.00	1741

185

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
***	**	**	***	********	********	********	********	********	********	********	********	********	********	********
		65		-33.000		1.019								1742
		74												1743
				-34.500		1.016								1744
				-45.000		0.475								1745
				-50.500		0.352								1746
				-55.000		0.342								1747
				-60.000		0.266								1748
				-62.584		0.227								1749
														1750
		80		-63.000		0.190								1751
				-70.000		0.086								1752
				-75.727		0.000								1753
		75												1754
				-76.727		1.000								1755
						3.000								1756
														1757
				-76.364				180.00						1758
														1759
109		74		-70.000		0.000								1760
				-65.000		0.095								1761
				-60.000		0.199								1762
				-55.000		0.275								1763
				-50.500		0.351								1764
				-45.000		0.361								1765
				-34.500		0.484								1766
				-29.500		1.026								1767
				-12.330		1.035								1768
				-19.330										1769
														1770
		64		-25.982				359.99	180.000					1771
														1772
														1773
													5.00	1774
		75		-29.500		1.029								1775
				-33.000										1776
														1777
														1778
														1779
		65		-34.500		1.026								1780
		74		-45.000		0.484								1781
				-50.500		0.361								1782
				-55.000		0.351								1783
				-60.000		0.275								1784
				-63.213		0.227								1785
														1786
		80		-65.000		0.199								1787
				-70.000		0.095								1788
				-76.364		-0.000								1789
														1790

186

N . G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
*** ** ** ***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
75	-77.364		1.000								1791
			3.000								1792
	-77.000				180.00						1793
											1794
											1795
110			0.000								1796
74	-70.000		0.104								1797
	-65.000		0.209								1798
	-60.000		0.285								1799
	-55.000		0.361								1800
	-50.500		0.370								1801
	-45.000		0.494								1802
	-34.500		1.035								1803
	-29.500		1.045								1804
	-12.330										1805
	-19.330										1806
4 64	-26.001				359.99	0.000					1807
75										5.00	1808
	-29.500		1.038								1809
	-33.000										1810
65 74	-34.500		1.035								1811
	-45.000		0.494								1812
	-50.500		0.370								1813
	-55.000		0.361								1814
	-60.000		0.285								1815
	-63.843		0.227								1816
80	-65.000		0.209								1817
	-70.000		0.104								1818
	-77.000		-0.000								1819
75	-78.000		1.000								1820
			3.000								1821
	-80.333				180.00						1822
											1823
111			0.000								1832
74	-77.000		0.009								1833
	-70.000		0.114								1834
	-65.000		0.218								1835
	-60.000		0.294								1836
	-55.000		0.370								1838

187

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
				-50.500		0.380							
				-45.000		0.503							
				-34.500		1.045							
				-29.500		1.054							
				-12.330									
				-19.330				359.99	180.000				5.00
64				-26.021									
4			75										
65				-29.500		1.048							
74				-33.000									
				-34.500		1.045							
				-45.000		0.503							
				-50.500		0.380							
				-55.000		0.370							
				-60.000		0.294							
				-65.000		0.218							
				-67.339		0.170							
80				-70.000		0.114							
				-72.000		0.009							
				-80.333		-0.000							
75				-81.333		1.000							
				-83.667		3.000		180.00					
112													
74				-77.000		0.000							
				-70.000		0.019							
				-65.000		0.123							
				-60.000		0.228							
				-55.000		0.304							
				-50.500		0.380							
				-45.000		0.389							
				-34.500		0.513							
				-29.560		1.054							
				-12.330		1.064							
				-19.330				359.99	0.000				5.00
64				-26.041									
4			75										

Sequence numbers (right margin):
1839, 1840, 1841, 1842, 1843, 1844, 1845, 1846, 1847, 1848, 1849, 1850, 1851, 1852, 1853, 1854, 1855, 1856, 1857, 1858, 1859, 1860, 1861, 1862, 1863, 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
		65		-29.500										1888
		74		-33.000		1.057								1889
				-34.500		1.054								1890
				-45.000		0.513								1891
				-50.500		0.389								1892
				-55.000		0.380								1893
				-60.000		0.304								1894
				-65.000		0.228								1895
				-70.000		0.123								1896
				-70.593		0.115								1897
														1898
														1899
		80		-77.000		0.019								1900
				-83.667		-0.000								1901
		75		-84.667		1.000		180.00						1902
				-87.000		3.000								1903
														1904
														1905
														1906
														1907
113		74		-77.000		0.000								1908
				-70.000		0.028								1909
				-65.000		0.133								1910
				-60.000		0.237								1911
				-55.000		0.313								1912
				-50.500		0.389								1913
				-45.000		0.399								1914
				-34.500		0.522								1915
				-29.500		1.064								1916
				-12.330		1.073								1917
				-19.330										1918
														1919
														1920
														1921
														1922
4		64		-26.061				359.99	180.000					1923
		75											5.00	1924
														1925
		65		-29.500										1926
		74		-33.000		1.067								1927
														1928
														1929
				-34.500		1.064								1930
				-45.000		0.522								1931
				-50.500		0.399								1932
				-55.000		0.389								1933
				-60.000		0.313								1934
				-65.000		0.237								1935
				-70.000		0.133								1936

189

* * CH47FRB ROOT LOOP PLU 51 THRU 144 (IITRI GENERATED) * *   ATLAS CONTROL TAPE LIST 27-AUG-76 13:53:21   PAGE 41

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
				*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
80				-73.899		0.075								1937
				-77.000		0.028								1938
				-87.000		-0.000								1939
75														1940
				-88.000		1.000								1941
						3.000								1942
														1943
				-90.333				180.00						1944
														1945
114														
	74			-77.000		0.000								1946
				-70.000		0.038								1947
				-65.000		0.142								1948
				-60.000		0.247								1949
				-55.000		0.323								1950
				-50.500		0.399								1951
				-45.000		0.408								1952
				-34.500		0.532								1953
				-29.500		1.073								1954
				-12.330		1.083								1955
				-19.330										1956
														1957
														1958
				-26.081				359.99	0.000					1959
														1960
														1961
64													5.00	1962
4	75			-29.500		1.076								1963
														1964
65				-33.000										1965
	74			-34.500		1.073								1966
				-45.000		0.532								1967
				-50.500		0.408								1968
				-55.000		0.399								1969
				-60.000		0.323								1970
				-65.000		0.247								1971
				-70.000		0.142								1972
				-77.000		0.038								1973
				-77.218		0.037								1974
														1975
80				-90.333		-0.000								1976
														1977
75				-91.333		1.000								1978
						3.000		180.00						1979
														1980
				-93.667										1981
														1982
														1983

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
115														
			74			0.000								1984
				-77.000		0.047								1985
				-70.000		0.152								1986
				-65.000		0.256								1987
				-60.000		0.332								1988
				-55.500		0.409								1989
				-50.500		0.418								1990
				-45.000		0.542								1991
				-34.500		1.083								1992
				-29.500		1.092								1993
				-12.330										1994
				-19.330										1995
			64	-26.101				359.99	180.000					1996
4			75	-29.500		1.086								1997
				-33.000										1998
														1999
			65										5.00	2000
			74	-34.500		1.083								2001
				-45.000		0.541								2002
				-50.500		0.418								2003
				-55.000		0.408								2004
				-60.000		0.332								2005
				-65.000		0.256								2006
				-70.000		0.152								2007
				-77.000		0.047								2008
				-80.543		0.037								2009
														2010
			80	-93.667		-0.000								2011
			75	-94.667		1.000								2012
						3.000								2013
														2014
				-97.000				180.00						2015
														2016
														2017
														2018
														2019
														2020
														2021
116														2022
			74			0.000								2023
				-77.000		0.057								2024
				-70.000		0.161								2025
				-65.000		0.266								2026
				-60.000		0.342								2027
				-55.500		0.418								2028
				-50.500		0.427								2029
				-45.000		0.551								2030
				-34.500		1.092								2031

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
***	**	**	***	********	********	********	********	********	********	********	********	********	********
				-29.500		1.102							
				-12.330									
				-19.330									
64				-26.121				359.99	0.000				5.00
4	75			-29.500		1.095							
				-33.000									
65	74			-34.500		1.092							
				-45.000		0.551							
				-50.500		0.427							
				-55.000		0.418							
				-60.000		0.342							
				-65.000		0.266							
				-70.000		0.161							
				-77.000		0.057							
				-83.871		0.037							
80				-97.000		-0.000							
75				-98.000		1.000							
						3.000							
117				-100.333		-0.000		180.00					
74				-77.000		0.066							
				-70.000		0.171							
				-65.000		0.275							
				-60.000		0.351							
				-55.000		0.427							
				-50.500		0.437							
				-45.000		0.560							
				-34.500		1.102							
				-29.500		1.111							
				-12.330									
				-19.330									
64				-26.140				359.99	180.000				5.00
4	75			-29.500		1.105							
65				-33.000									

2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080

** CH47FRB ROOT LOOP PLU 51 THRU 144 (IITRI GENERATED) **   ATLAS CONTROL TAPE LIST   27-AUG-76   13:53:21   PAGE 4;

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
74				-34.500		1.102								2081
				-45.000		0.560								2082
				-50.500		0.437								2083
				-55.000		0.427								2084
				-60.000		0.351								2085
				-65.000		0.275								2086
				-70.000		0.171								2087
				-77.000		0.066								2088
				-87.201		0.037								2089
			80	-100.333		-0.000								2090
														2091
			75	-101.333		1.000								2092
						3.000								2093
														2094
														2095
				-103.667				180.00						2096
														2097
118														
74				-77.000		0.000								2098
				-70.000		0.076								2099
				-65.000		0.180								2100
				-60.000		0.285								2101
				-55.000		0.361								2102
				-50.500		0.437								2103
				-45.000		0.446								2104
				-34.500		0.570								2105
				-29.500		1.111								2106
				-12.330		1.121								2107
				-19.330				359.99	0.000					2108
			64	-26.160									5.00	2109
4			75	-29.500		1.114								2110
				-33.000										2111
														2112
65														2113
74				-34.500		1.111								2114
				-45.000		0.570								2115
				-50.500		0.446								2116
				-55.000		0.437								2117
				-60.000		0.361								2118
				-65.000		0.285								2119
				-70.000		0.180								2120
				-77.000		0.076								2121
														2122
														2123
														2124
														2125
														2126
			80	-90.531		0.037								2127
														2128
														2129

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	(tape)
****	***	**	**	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
	75			-103.667		-0.000								2130
				-104.667		1.000								2131
						3.000								2132
								180.00						2133
				-107.000		-0.000								2134
														2135
119														2136
	74					0.000								2137
				-77.000		0.085								2138
				-70.000		0.190								2139
				-65.000		0.294								2140
				-60.000		0.370								2141
				-55.000		0.446								2142
				-50.500		0.456								2143
				-45.000		0.579								2144
				-34.500		1.121								2145
				-29.500		1.130								2146
				-12.330										2147
				-19.330										2148
								359.99	180.000					2149
4	64			-26.180		1.124								2150
													5.00	2151
	75			-29.500										2152
				-33.000										2153
65	74			-34.500		1.121								2154
				-45.000		0.579								2155
				-50.500		0.456								2156
				-55.000		0.446								2157
				-60.000		0.370								2158
				-65.000		0.294								2159
				-70.000		0.190								2160
				-77.000		0.085								2161
				-93.862		0.037								2162
80				-107.000		-0.000								2163
	75			-108.000		1.000								2164
						3.000								2165
								180.00						2171
				-110.333										2173
120														2174
	74					0.000								2175
				-77.000		0.095								2176
				-70.000		0.199								2177

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	**	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
2178				-65.000		0.304							
2179				-60.000		0.380							
2180				-55.000		0.456							
2181				-50.500		0.465							
2182				-45.000		0.589							
2183				-34.500		1.130							
2184				-29.500		1.140							
2185													
2186				-12.330									
2187				-19.330									
2188													
2189													
2190	4		64	-26.200				359.99	0.000				5.00
2191			75	-29.500									
2192				-33.000		1.133							
2193			65	-34.500		1.130							
2194			74	-45.000		0.589							
2195				-50.500		0.465							
2196				-55.000		0.456							
2197				-60.000		0.380							
2198				-65.000		0.304							
2199				-70.000		0.199							
2200				-77.000		0.095							
2201				-97.194		0.037							
2202			80	-110.333		-0.000							
2203			75	-111.333		1.000		180.00					
2204						3.000							
2205													
2206													
2207													
2208													
2209													
2210													
2211	121		74	-113.667		0.000							
2212				-77.000		0.104							
2213				-70.000		0.209							
2214				-65.000		0.313							
2215				-60.000		0.389							
2216				-55.000		0.465							
2217				-50.500		0.475							
2218				-45.000		0.598							
2219				-34.500		1.140							
2220				-29.500		1.149							
2221				-12.330									
2222				-19.330									
2223													
2224				-26.220				359.99	180.000				
2225													
2226													

195

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
2227			64										
2228			75	-29.500		1.143							5.00
2229				-33.000									
2230													
2231			65	-34.500		1.140							
2232			74	-45.000		0.598							
2233				-50.500		0.475							
2234				-55.000		0.465							
2235				-60.000		0.389							
2236				-65.000		0.313							
2237				-70.000		0.209							
2238				-77.000		0.104							
2239				-100.526		0.037							
2240			80	-113.667		0.000		180.00					
2241			75	-114.667		1.000							
2242						3.000							
2243				-117.000		0.000							
2244													
2245													
2246													
2247													
2248													
2249													
2250			74	-77.000		0.000							
2251				-70.000		0.114							
2252				-65.000		0.218							
2253				-60.000		0.323							
2254				-55.000		0.399							
2255				-50.500		0.475							
2256				-45.000		0.485							
2257				-34.500		0.608							
2258				-29.500		1.149							
2259				-12.330		1.159							
2260				-19.330									
2261				-26.240				359.99	0.000				
2262			64	-29.500		1.152							5.00
2263			75	-33.000									
2264													
2265			65	-34.500		1.149							
2266			74	-45.000		0.608							
2268				-50.500		0.484							
2269				-55.000		0.475							
2270													
2271													
2272													
2273													
2274													
2275													

196

122

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
				-60.000		0.399								2276
				-65.000		0.323								2277
				-70.000		0.218								2278
				-77.000		0.114								2279
				-103.858		0.037								2280
80				-117.000		-0.000								2281
														2282
75				-118.000		1.000								2283
						3.000								2284
								180.00						2285
				-118.750										2286
														2287

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
123														
74				-117.000		0.000								2288
														2289
				-77.000		0.009								2290
				-70.000		0.123								2291
				-65.000		0.228								2292
				-60.000		0.332								2293
				-55.000		0.409								2294
				-50.500		0.485								2295
				-45.000		0.494								2296
				-34.500		0.617								2297
				-29.500		1.159								2298
				-12.330		1.168								2299
				-19.330										2300
														2301
								359.99	180.000					2302
64	4			-26.260										2303
														2304
													5.00	2305
75				-29.500		1.162								2306
														2307
65				-33.000										2308
74														2309
				-34.500		1.159								2310
				-45.000		0.617								2311
				-50.500		0.494								2312
				-55.000		0.484								2313
				-60.000		0.408								2314
				-65.000		0.332								2315
				-70.000		0.228								2316
				-77.000		0.123								2317
				-105.962		0.041								2318
														2319
80				-117.000		0.009								2320
				-118.750		-0.000								2321
75														2322
				-119.750		1.000								2323
														2324

197

* * CH47FRB ROOT LOOP PLU 51 THRU 144 ((IITRI GENERATED) * *   ATLAS CONTROL TAPE LIST 27-AUG-76 13:53:21   PAGE 4?

N	G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
124												
	74	-120.500		3.000		180.00						2325
												2326
												2327
				0.000								2328
		-117.000		0.019								2329
		-77.000		0.133								2330
		-70.000		0.237								2331
		-65.000		0.342								2332
		-60.000		0.418								2333
		-55.000		0.494								2334
		-50.500		0.504								2335
		-45.000		0.627								2336
		-34.500		1.169								2337
		-29.500		1.178								2338
		-12.330										2339
		-19.330										2340
												2341
												2342
												2343
4	64	-26.279				359.99	0.000			5.00		2344
	75	-29.500		1.171								2345
		-33.000		1.171								2346
	65											2347
	74	-34.500		1.168								2348
		-45.000		0.627								2349
		-50.500		0.503								2350
		-55.000		0.494								2351
		-60.000		0.418								2352
		-65.000		0.342								2353
		-70.000		0.237								2354
		-77.000		0.133								2355
		-107.551		0.046								2356
	80											2357
		-117.000		0.019								2358
		-120.500		-0.000								2359
	75	-121.500		1.000		180.00						2360
				3.000								2361
		-122.250		0.000		180.00						2362
												2363
												2364
												2365
												2366
												2367
125												2368
	74	-117.000		0.028								2369
		-77.000		0.142								2370
		-70.000		0.247								2371
												2372

N G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
	-65.000		0.351								2373
	-60.000		0.427								2374
	-55.000		0.503								2375
	-50.500		0.513								2376
	-45.000		0.636								2377
	-34.500		1.178								2378
	-29.500		1.187								2379
	-12.330										2380
	-19.330										2381
											2382
4 64	-26.299				359.99	180.000					2383
											2384
75										5.00	2385
	-29.500										2386
	-33.000		1.181								2387
											2388
65	-34.500		1.178								2389
74	-45.000		0.636								2390
	-50.500		0.513								2391
	-55.000		0.503								2392
	-60.000		0.427								2393
	-65.000		0.351								2394
	-70.000		0.247								2395
	-77.000		0.142								2396
	-109.240		0.051								2397
											2398
80	-117.000		0.028								2399
	-122.250		-0.000								2400
											2401
75	-123.250		1.000								2402
			3.000		180.00						2403
											2404
	-124.000		0.000								2405
126											2406
											2407
74	-117.000		0.038								2408
	-77.000		0.152								2409
	-70.000		0.256								2410
	-65.000		0.361								2412
	-60.000		0.437								2413
	-55.000		0.513								2414
	-50.500		0.523								2415
	-45.000		0.646								2416
	-34.500		1.187								2417
	-29.500		1.197								2418
	-12.330										2419
	-19.336										2420
											2421

199

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
			64	-26.319				359.99	0.000					2422
	4	75		-29.500									5.00	2423
				-33.000		1.190								2424
		65												2425
		74												2426
				-34.500		1.187								2427
				-45.000		0.646								2428
				-50.500		0.522								2429
				-55.000		0.513								2430
				-60.000		0.437								2431
				-65.000		0.361								2432
				-70.000		0.256								2433
				-77.000		0.152								2434
				-110.959		0.055								2435
			80	-117.000		0.038								2436
				-124.000		-0.000								2437
		75		-125.000		1.000								2438
						3.000								2439
				-134.000				180.00						2440
														2441
														2442
														2443
														2444
														2445
														2446
														2447
127		74		0.000		0.000								2448
				-124.000		0.009								2449
				-117.000		0.047								2450
				-77.000		0.161								2451
				-70.000		0.266								2452
				-65.000		0.370								2453
				-60.000		0.446								2454
				-55.000		0.522								2455
				-50.500		0.532								2456
				-45.000		0.655								2457
				-34.500		1.197								2458
				-29.500		1.206								2459
				-12.330										2460
				-19.330				359.99	180.000					2461
			64	-26.339									5.00	2462
	4	75		-29.500										2463
		65		-33.000		1.200								2464
														2465
														2466
														2467
														2468
														2469
														2470

N	C M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
2471	74	-34.500		1.197							
2472		-45.000		0.655							
2473		-50.500		0.532							
2474		-55.000		0.522							
2475		-60.000		0.446							
2476		-65.000		0.370							
2477		-70.000		0.266							
2478		-77.000		0.161							
2479		-117.000		0.047							
2480		-121.932		0.026							
2481	80	-124.000		0.009							
2482		-134.000		-0.000							
2483	75	-135.000		1.000							
2484				3.000							
2485		-162.667				180.00					
2486											
2487											
2488											
2489											

- -

128

N	C M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
2490	74	-134.000		0.000							
2491		-124.000		0.009							
2492		-117.000		0.019							
2493		-77.000		0.057							
2494		-70.000		0.171							
2495		-65.000		0.275							
2496		-60.000		0.380							
2497		-55.000		0.456							
2498		-50.500		0.532							
2499		-45.000		0.542							
2500		-34.500		0.665							
2501		-29.500		1.206							
2502		-12.330		1.216							
2503		-19.330									
2504											
2505											
2506	4	-26.359				359.99	0.000				
2507											
2508	64										
2509	75	-29.500									5.00
2510		-33.000		1.209							
2511											
2512	65										
2513	74	-34.500		1.206							
2514		-45.000		0.665							
2515		-50.500		0.541							
2516		-55.000		0.532							
2517		-60.000		0.456							
2518											
2519											

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
2520				-65.000		0.380							
2521				-70.000		0.275							
2522				-77.000		0.171							
2523				-117.000		0.057							
2524				-124.000		0.019							
2525				-134.000		0.009							
2526				-149.724		0.004							
2527			80	-162.667		-0.000							
2528													
2529			75	-163.667		1.000							
2530						3.000							
2531								180.00					
2532				-191.333									
2533						0.000							
2534			129										
2535			74	-134.000		0.019							
2536				-124.000		0.028							
2537				-117.000		0.066							
2538				-77.000		0.180							
2539				-70.000		0.285							
2540				-63.000		0.389							
2541				-60.000		0.465							
2542				-55.000		0.541							
2543				-50.500		0.551							
2544				-45.000		0.674							
2545				-34.500		1.216							
2546				-29.500		1.225							
2547				-12.330									
2548				-19.330									
2549			4										
2550			64	-26.379				359.99	180.000				
2551													
2552													
2553			75	-29.500		1.219							5.00
2554				-33.000									
2555			65	-34.500		1.216							
2556			74	-45.000		0.674							
2557				-50.500		0.551							
2558				-55.000		0.541							
2559				-60.000		0.465							
2560				-65.000		0.389							
2561				-70.000		0.285							
2562						0.180							
2563													
2564													
2565													
2566						0.066							
2567				-117.000									
2568				-124.000		0.028							

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
2569				-134.000		0.019							
2570				-178.378		0.004							
2571	80			-191.333		-0.000							
2572													
2573		75		-192.333		1.000							
2574						3.000							
2575													
2576													
2577				-220.000				180.00					
2578	130					0.000							
2579	74			-134.000		0.028							
2580				-124.000		0.038							
2581				-117.000		0.076							
2582				-77.000		0.190							
2583				-70.000		0.294							
2584				-65.000		0.399							
2585				-60.000		0.475							
2586				-55.000		0.551							
2587				-50.500		0.560							
2588				-45.000		0.684							
2589				-34.500		1.225							
2590				-29.500		1.235							
2591				-12.330									
2592				-19.330									
2593				-26.399				359.99					
2594	64								0.000				
2595	4	75		-29.500		1.228							
2596				-33.000									5.00
2597	65	74		-34.500		1.225							
2598				-45.000		0.684							
2599				-50.500		0.560							
2600				-55.000		0.551							
2601				-60.000		0.475							
2602				-65.000		0.399							
2603				-70.000		0.294							
2604				-77.000		0.190							
2605				-117.000		0.076							
2606				-124.000		0.038							
2607				-134.000		0.028							
2608	80			-207.041		0.004							
2609	75			-220.000		-0.000							
2610													
2611													
2612													
2613													
2614													
2615													
2616													
2617													

N G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
**** **	********	********	********	********	********	********	********	********	********	********	
	-221.000		1.000		180.00						2618
	-248.667		3.000								2619
											2620
											2621
131			0.000								2622
74											2623
	-134.000		0.038								2624
	-124.000		0.047								2625
	-117.000		0.085								2626
	-77.000		0.200								2627
	-70.000		0.304								2628
	-65.000		0.409								2629
	-60.000		0.485								2630
	-55.000		0.560								2631
	-50.500		0.570								2632
	-45.000		0.694								2633
	-34.500		1.235								2634
	-29.500		1.244								2635
	-19.330										2636
	-26.418				359.99	180.000					2637
64											2638
4											2639
75	-29.500		1.238							5.00	2640
	-33.000										2641
65											2642
74	-34.500		1.235								2643
	-45.000		0.693								2644
	-50.500		0.570								2645
	-55.000		0.560								2646
	-60.000		0.484								2647
	-65.000		0.408								2648
	-70.000		0.304								2649
	-77.000		0.199								2650
	-117.000		0.085								2651
	-124.000		0.047								2652
	-134.000		0.038								2653
	-235.705		0.004								2654
80	-248.667		-0.000								2655
75	-249.667		1.000								2656
			3.000								2657
	-277.333				180.00						2658
											2659
											2660
											2661
											2662
											2663
											2664
											2665

N	C	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	SEQ
132						0.000								2666
			74	-134.000		0.047								2667
				-124.000		0.057								2668
				-117.000		0.095								2669
				-77.000		0.209								2670
				-70.000		0.314								2671
				-65.000		0.418								2672
				-60.000		0.494								2673
				-55.000		0.570								2674
				-50.500		0.579								2675
				-45.000		0.703								2676
				-34.500		1.244								2677
				-29.500		1.254								2678
				-12.330										2679
				-19.330										2680
			64	-26.438		1.247		359.99	0.000					2681
			4											2682
			75	-29.500		1.247							5.00	2683
				-33.000		1.244								2684
			65	-34.500		1.244								2685
			74	-45.000		0.703								2686
				-50.500		0.579								2687
				-55.000		0.570								2688
				-60.000		0.494								2689
				-65.000		0.418								2690
				-70.000		0.313								2691
				-77.000		0.209								2692
				-117.000		0.095								2693
				-124.000		0.057								2694
				-134.000		0.047								2695
				-264.371		0.004								2696
			80	-277.333		-0.000								2697
			75	-278.333		1.000								2698
						3.000								2699
				-306.000		0.000		180.00						2700
														2701
														2702
														2703
														2704
														2705
														2706
														2707
														2708
														2709
133						0.000								2710
			74	-134.000		0.657								2711
				-124.000		0.066								2712
														2713

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
				-117.000		0.104								2714
				-77.000		0.218								2715
				-70.000		0.323								2716
				-65.000		0.427								2717
				-60.000		0.503								2718
				-55.000		0.579								2719
				-50.500		0.589								2720
				-45.000		0.712								2721
				-34.500		1.254								2722
				-29.500		1.263								2723
				-12.330										2724
				-19.330										2725
														2726
														2727
64				-26.458				359.99	180.000					2728
4													5.00	2729
75				-29.500		1.257								2730
				-33.000		1.254								2731
65				-34.500		1.254								2732
74				-45.000		0.712								2733
				-50.500		0.589								2734
				-55.000		0.579								2735
				-60.000		0.503								2736
				-65.000		0.427								2737
				-70.000		0.323								2738
				-77.000		0.218								2739
				-117.000		0.104								2740
				-124.000		0.066								2741
				-134.000		0.057								2742
				-293.036		0.004								2743
														2744
														2745
														2746
														2747
80				-306.000		-0.000								2748
														2749
75				-307.000		1.000								2750
						3.000		180.00						2751
														2752
				-363.000		0.000								2753
134														
74				-306.000		0.009								2754
				-134.000		0.066								2755
				-124.000		0.076								2756
				-117.000		0.114								2757
				-77.000		0.228								2758
				-70.000		0.332								2759
				-65.000		0.437								2760
														2761
														2762

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
				-60.000		0.513								2763
				-55.000		0.589								2764
				-50.500		0.598								2765
				-45.000		0.722								2766
				-34.500		1.263								2767
				-29.500		1.273								2768
				-12.330										2769
				-19.330										2770
64				-26.478				359.99	0.000					2771
75				-29.500										2772
				-33.000		1.266							5.00	2773
65														2774
74				-34.500		1.263								2775
				-45.000		0.722								2776
				-50.500		0.598								2777
				-55.000		0.589								2778
				-60.000		0.513								2779
				-65.000		0.437								2780
				-70.000		0.332								2781
				-77.000		0.228								2782
				-117.000		0.114								2783
				-124.000		0.076								2784
				-134.000		0.067								2785
				-306.000		0.010								2786
				-350.051		0.002								2787
80				-363.000		0.000		180.00						2788
75				-364.000		1.000								2789
						3.000								2790
				-363.000		0.000								2791
135														2792
74				-363.000		0.009								2793
				-306.000		0.019								2794
				-134.000		0.076								2795
				-124.000		0.085								2796
				-117.000		0.123								2797
				-77.000		0.237								2798
				-70.000		0.342								2799
				-65.000		0.446								2800
				-60.000		0.522								2801
				-55.000		0.598								2802

207

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
2812				-50.500		0.608							
2813				-45.000		0.731							
2814				-34.500		1.273							
2815				-29.500		1.282							
2816				-12.330									
2817				-19.330									
2818													
2819			64	-26.498				359.99	180.000				5.00
2820			4										
2821			75	-29.500									
2822				-33.000									
2823			65			1.276							
2824			74	-34.500		1.273							
2825				-45.000		0.731							
2826				-50.000		0.608							
2827				-55.000		0.598							
2828				-60.000		0.522							
2829				-65.000		0.446							
2830				-70.000		0.342							
2831				-77.000		0.237							
2832				-117.000		0.123							
2833				-124.000		0.085							
2834				-134.000		0.076							
2835				-306.000		0.019							
2836				-351.333		0.011							
2837													
2838			80	-363.000		0.009							
2839				-363.000		-0.000							
2840			75										
2841				-363.000		3.000		180.00					
2842													
2843													
2844													
2845													
2846			136										
2847			74	-363.000		0.000							
2848				-363.000		0.019							
2849				-306.000		0.028							
2850				-134.000		0.085							
2851				-124.000		0.095							
2852				-117.000		0.133							
2853				-77.000		0.247							
2854				-70.000		0.351							
2855				-65.000		0.456							
2856				-60.000		0.532							
2857				-55.000		0.608							
2858				-50.500		0.517							

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
2861				-45.000		0.741							
2862				-34.500		1.282							
2863				-29.500		1.292							
2864				-12.330									
2865				-19.330									
2866													
2867	64			-26.518				359.99	0.000				
2868		4											
2869	75			-29.500									5.00
2870				-33.000		1.285							
2871													
2872	65			-34.500		1.282							
2873	74			-45.000		0.741							
2874				-50.500		0.617							
2875				-55.000		0.608							
2876				-60.000		0.532							
2877				-65.000		0.456							
2878				-70.000		0.351							
2879				-77.000		0.247							
2880				-117.000		0.133							
2881				-124.000		0.095							
2882				-134.000		0.085							
2883				-306.000		0.028							
2884				-351.343		0.021							
2885													
2886	80			-363.000		0.019							
2887				-363.000		-0.000							
2888													
2889	75			-364.000		1.000							
2890						3.000		180.00					
2891													
2892													
2893													
2894													
2895				-363.000		0.000							

2896	137			-363.000		0.000							
2897													
2898	74			-363.000		0.028							
2899				-306.000		0.038							
2900				-134.000		0.095							
2901				-124.000		0.104							
2902				-117.000		0.142							
2903				-77.000		0.256							
2904				-70.000		0.361							
2905				-65.000		0.465							
2906				-60.000		0.541							
2907				-55.000		0.617							
2908				-50.500		0.627							
2909				-45.000		0.750							

209

N	G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	N
***	** ***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
		-34.500		1.292								2910
		-29.500		1.301								2911
		-12.330										2912
		-19.330										2913
												2914
	4 64	-26.538				359.99	180.000					2915
												2916
											5.00	2917
	75											2918
		-29.500										2919
	65 74	-33.000		1.295								2920
												2921
		-34.500		1.292								2922
		-45.000		0.750								2923
		-50.500		0.627								2924
		-55.000		0.617								2925
		-60.000		0.541								2926
		-65.000		0.465								2927
		-70.000		0.361								2928
		-77.000		0.256								2929
		-117.000		0.142								2930
		-124.000		0.104								2931
		-134.000		0.095								2932
		-306.000		0.038								2933
		-351.352		0.030								2934
												2935
	80	-363.000		0.028								2936
		-363.000		-0.000								2937
												2938
	75	-364.000		1.000								2939
		-363.000		3.000		180.00						2940
												2941
												2942
		-363.000										2943
138	74	-363.000		0.000								2944
		-306.000		0.038								2945
		-134.000		0.047								2946
		-124.000		0.104								2947
		-117.000		0.114								2948
		-77.000		0.152								2949
		-70.000		0.266								2950
		-65.000		0.370								2951
		-60.000		0.475								2952
		-55.500		0.551								2953
		-50.500		0.627								2954
		-45.000		0.636								2955
		-34.500		0.760								2956
				1.301								2957
												2958

** CH47FRB ROOT LOOP PLU 51 THRU 144 (IITR1 GENERATED) **   ATLAS CONTROL TAPE LIST 27-AUG-76 13:53:21   PAGE 62

N G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
**** ** ***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
	-29.500		1.311		359.99	0.000				5.00
	-12.330									
	-19.330									
64	-26.557									
75	-29.500		1.304							
65	-33.000									
74	-34.500		1.301							
	-45.000		0.760							
	-50.500		0.636							
	-55.000		0.627							
	-60.000		0.551							
	-65.000		0.475							
	-70.000		0.370							
	-77.000		0.266							
	-117.000		0.152							
	-124.000		0.114							
	-134.000		0.104							
	-306.000		0.047							
	-351.362		0.040							
80	-363.000		0.038							
	-363.000		-0.000							
75	-364.000		1.000		180.00					
			3.000							

2959
2960
2961
2962
2963
2964
2965
2966
2967
2968
2969
2970
2971
2972
2973
2974
2975
2976
2977
2978
2979
2980
2981
2982
2983
2984
2985
2986
2987
2988
2989
2990

211

3.3   Original Boeing Tape - First 50 Plies.

** CH47FRB ROOT LOOP PLU 1 THRU 50 (ORIGINAL FROM BOEING) **   ATLAS CONTROL TAPE LIST 27-AUG-76 10:40:13   PAGE 1

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
0				0.000	0.000	35.000	0.000	270.00	-0.000				
		98				33.700							
			62										
			75		41.954	31.522							
1													
	4		74			29.700							
													1.00
	4				43.391								
													1.00
	4		80		46.790								
													1.00
	4				51.626					180.000			
													1.00
			75					90.00					
					51.751	32.522							
2													
	4		74			29.700							
													1.00
	4				50.036								
													1.00
	4		80		46.790								
													1.00
	4				41.829					-0.000			
													1.00
			75					270.00					
					41.614	32.522							
3													
	4		74			29.700							
													1.00
	4				43.607								
													1.00
	4		50		46.790								
													1.00
	4				46.790					180.000			
													1.00
			75		51.876	32.522							

213

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
48	4				52.001			90.00					
49						29.700							1.00
50													
51	4	74											
52					49.730								1.00
53	4												
54	4	80											
55					46.790								1.00
56	4												
57					46.790					-0.000				
58													
59					41.579								
60			75										
61													
62					41.454	32.522		270.00					
63	5	4				29.700							1.00
64					44.003								
65	4	74											
66	4												1.00
67	4	80											
68					46.790								1.00
69	4												
70									180.000				
71					52.126								
72					52.251								
73			75										
74													
75													
76					52.251	32.522		90.00					
77	6	4				29.700							1.00
78													
79	4	74											
80					49.424								1.00
81	4	80											
82													1.00
83	4												
84					46.790					-0.000				
85													
86													
87			75										
88					41.329								
89													
90					41.204	32.522		270.00					
91	7	4				29.700							1.00
92		74											
93													

Line	N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
94														1.00
95		4	80			44.310								1.00
96		4												
97		4	80			46.790				180.000				1.00
98		4												
99														
100						52.376								
101			75				32.522							
102														
103														
104						52.411			90.00					
105	8						29.700							1.00
106		4	74											
107														1.00
108		4												
109		4	80			49.027								1.00
110														
111														
112														
113														
114						46.790				-0.000				1.00
115		4				41.079								
116														
117			75				32.522							
118						40.954			270.00					
119	9						29.700							1.00
120		4	74											1.00
121														
122														1.00
123		4												
124		4	80			44.617								1.00
125														
126														
127														
128						46.790				180.000				
129														
130			75			52.626								
131							32.522							
132						52.751			90.00					
133	10						29.700							1.00
134		4	74											
135														1.00
136		4												1.00
137		4	80			48.810								1.00
138														1.00
139		4												

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
***	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	********
					46.790				-0.000				
					40.829								
			75			32.522		270.00					
					40.704								
11						29.800							
	4	74											1.00
	4				44.923								1.00
	4	80											1.00
	4				46.790				180.000				1.00
					52.876								
			75			32.522		90.00					
					53.001								
12						29.800							
	4	74											1.00
	4				48.504								1.00
	4	80											1.00
	4				46.790				-0.000				1.00
					40.579								
			75		40.454	32.522		270.00					
13						29.800							
	4	74											1.00
	4				45.229								1.00
	4	80											1.00
	4				46.790				180.000				1.00
			75		53.126	32.522							

Line numbers: 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187

* * CH47FRB ROOT LOOP PLU 1 THRU 50 (ORIGINAL FROM BOEING) * *   ATLAS CONTROL TAPE LIST   27-AUG-76   10:40:13   PAGE   5

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
14				53.251				90.00						188
						29.800							1.00	189
	4	74												190
	4				48.197								1.00	191
														192
														193
	4	80											1.00	194
	4				46.790				-0.000					195
														196
					40.329									197
														198
		75												199
					40.204	32.522		270.00						200
														201
15						29.800								202
	4	74											1.00	203
	4													204
					45.446									205
	4	80											1.00	206
	4				46.790				180.000				1.00	207
														208
					53.376									209
														210
		75												211
					53.501	32.522		90.00						212
														213
														214
														215
16						29.800								216
	4	74											1.00	217
	4													218
					47.891								1.00	219
	4	80												220
	4				46.790				-0.000				1.00	221
														222
					40.079									223
														224
		75												225
					39.954	32.522		270.00						226
														227
														228
														229
17						29.800								230
	4	74											1.00	231
	4													232
													1.00	233

217

* * CH47FRB ROOT LOOP PLU 1 THRU 50 (ORIGINAL FROM BOEING) * *

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
				********	********	*********	*********	*********	*********	*********	*********	*********	*********	
	4		80		45.842								1.00	234
														235
	4				46.790				180.000				1.00	236
					53.626	32.522								237
														238
														239
	75				53.830	32.522		90.00						240
														241
														242
18														243
	4		74			29.800							1.00	244
														245
	4				47.505								1.00	246
														247
	4		80		46.790				-0.000				1.00	248
														249
	4				39.750								1.00	250
														251
														252
														253
														254
	75				39.546	32.522		270.00						255
														256
19														257
	4		74			29.800							1.00	258
														259
	4				46.307								1.00	260
														261
	4		80		46.790				180.000				1.00	262
														263
	4				54.034								1.00	264
														265
														266
														267
														268
	75				54.238	32.522		90.00						269
														270
20														271
	4		74			29.800							1.00	272
														273
	4				47.041								1.00	274
														275
	4		80										1.00	276
														277
	4				46.790								1.00	278
														279
														280

218

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
283			75		39.342				-0.000				
284					39.138	32.522		270.00					
285													
286													
287	4		74		46.772	29.900							1.00
288													
289	4												1.00
290	4		80		46.790								1.00
291													
292													
293	4												1.00
294					46.790				180.000				
295					54.442			90.00					
296													
297													
298			75		54.646	32.522							
299													
300					46.790	29.900							
301													
302	4		74										1.00
303	4												1.00
304									-173.470				
305													
306	4		80										1.00
307	4												1.00
308					38.934				-0.000				
309													
310	4		75										1.00
311	4												1.00
312													
313					38.730	32.522		270.00					
314													
315													
316					29.900								
317	4		74										1.00
318	4												1.00
319													
320	4		80		46.790				13.547				
321	4												1.00
322													1.00
323													
324													1.00
325					54.850				180.000				
326	4												1.00

21
22
23

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			75											328
			4		55.054	32.522		90.00					1.00	329
														330
														331
24														
			74		46.790	29.900							1.00	332
			4										1.00	333
			80						-159.503					334
			4										1.00	335
					38.256				-0.000				1.00	336
														337
													1.00	
			75											341
			4		38.322	32.522		270.00					1.00	
25														
			74		46.790	29.900							1.00	
			4										1.00	
			80						27.407					
			4										1.00	
					55.258				180.000					
													1.00	
			75											
			4		55.462	32.522		90.00					1.00	363
26														
			74		46.790	29.900							1.00	
			4										1.00	
			80						-145.723					
			4		46.790								1.00	
													1.00	
					38.118				-0.000					374

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
				*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
	4	75												375
													1.00	376
	4													377
													1.00	378
					37.914	32.522		270.00						379
27														380
	4	74				29.900							1.00	381
	4													382
					46.790								1.00	383
	4	80							40.983					384
														385
	4				55.666								1.00	386
									180.000					387
	4	75												388
	4				55.870	32.522		90.00					1.00	389
28														396
	4	74				29.900							1.00	397
	4				46.790				-132.323				1.00	399
	4	80												400
	4				37.710				-0.000				1.00	402
	4	75												405
	4				37.506	32.522		270.00					1.00	411
29														412
	4	74				29.900							1.00	414
	4				46.790				54.330				1.00	416
	4	80							180.000				1.00	419

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
					56.074									422
													1.00	423
	4		75											424
	4												1.00	425
					56.278	32.522		90.00						426
														427
30						29.900								428
	4		74										1.00	429
	4				46.790									430
													1.00	431
									-119.099					433
	4		80										1.00	434
	4								-0.000				1.00	436
					37.302									437
														438
	4		75										1.00	439
	4												1.00	441
					37.098	32.522		270.00						443
31						30.000								444
	4		74										1.00	445
	4				46.790									447
									67.412					448
													1.00	450
	4		80						180.000				1.00	452
	4				56.482									453
													1.00	455
	4		75										1.00	457
					56.686	32.522		90.00						459
32						30.000								460
	4		74										1.00	461
	4				46.790									463
									-107.168				1.00	463
	4		80										1.00	467
	4												1.00	468

N	G	M	S	K-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
				********	********	********	********	********	********	********	********	********	********	469
	4		75		36.896				-0.000				1.00	470
														471
	4												1.00	472
														473
	4				36.894	32.522		270.00						474
														475
33														476
	4		74				30.000						1.00	477
	4				46.790								1.00	478
														479
	4		80						80.273				1.00	480
	4												1.00	481
														482
														483
														484
	4				56.890				180.000				1.00	485
														486
														487
	4		75										1.00	488
	4				57.094	32.522		90.00					1.00	489
														490
														491
34														492
	4		74				30.000						1.00	493
	4				46.790								1.00	494
														495
	4		80						-93.392				1.00	496
	4												1.00	497
														498
														499
	4				36.485				-0.000				1.00	500
														501
														502
	4		75										1.00	503
	4				36.282	32.522		270.00					1.00	504
														505
														506
35														507
	4		74				30.000						1.00	508
	4				46.790								1.00	509
														510
	4		80						92.901				1.00	511
														512
														513
														514
														515

223

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	********	
	4								180.000				1.00	516
														517
					57.289									518
	4		75										1.00	519
														520
					57.507	32.522		90.00						521
														522
	4												1.00	523
36							30.000							524
	4		74										1.00	525
					46.790									526
														527
	4		80						-80.849				1.00	528
														529
														530
														531
	4				36.073				-0.000				1.00	532
														533
														534
	4		75										1.00	535
														536
														537
					35.856	32.522		270.00						538
	4												1.00	539
37							30.000							540
	4		74										1.00	541
														542
														543
	4		80		46.790				105.801				1.00	544
														545
														546
	4												1.00	547
					57.724				180.000					548
														549
													1.00	550
	4		75											551
														552
					57.941	32.522		90.00						553
														554
	4												1.00	555
38							30.000							556
	4		74										1.00	557
														558
														559
	4				46.790				-67.720				1.00	560
														561
	4													562

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
		80							-0.000				1.00
	4				35.639								1.00
	4	75											1.00
	4				35.422	32.522		270.00					
39													
	4	74				30.000							1.00
	4				46.790				118.711				1.00
	4	80											1.00
	4				58.158				180.000				1.00
	4	75											1.00
	4				58.375	32.522		90.00					1.00
40													
	4	74			46.790	30.000							1.00
	4								-54.925				1.00
	4	80											1.00
	4				35.205				-0.000				1.00
	4	75											1.00
	4				34.988	32.522		270.00					1.00
41													
	4	74			46.790	30.100							1.00
	4								131.384				1.00

563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609

225

* * CH47FRB ROOT LOOP PLU 1 THRU 50 (ORIGINAL FROM BOEING) * *   ATLAS CONTROL TAPE LIST   27-AUG-76   10:40:13

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
610	4	80											1.00
611	4												1.00
612					58.592				180.000				
613													
614	4												
615	4	75											1.00
616													
617	4												1.00
618					58.800	32.522							
619								90.00					
620	4												1.00
621	4	74											
622	4												
623					46.790	30.100								1.00
624													
625	4	80							-43.358					1.00
626	4												
627													
628					34.771				-0.000					1.00
629													
630	4	75											
631	4												1.00
632													
633													
634					34.554	32.522							
635								270.00					
636	4												1.00
637	4	74											
638	4												
639					46.790	30.100								1.00
640													
641	4	80							143.844					1.00
642	4												
643					59.026								
644									180.000					1.00
645	4	75											
646	4												1.00
647													
648													
649					59.243	32.522								1.00
650								90.00					
651													
652	4												1.00
653	4	74											
654	4												
655					46.790	30.100								1.00
656													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
				********	********	*********	*********	*********	*********	**********	**********	*********	*********
657									-30.010				1.00
658	4	80			34.337								
659													
660	4								-0.000				1.00
661													
662	4	75			34.120	32.522		270.00					
663	4												1.00
664													
665													1.00
666													
667													
45													
668	4	74				30.100							1.00
669	4												
670	4												1.00
671													
672					46.790				156.084				
673													
674	4	80											1.00
675	4												
676					59.460				180.000				1.00
677													
678													
679	4	75											1.00
680	4												
681													1.00
682					59.677	32.522		90.00					
683													
46													
684	4	74				30.100							1.00
685	4												
686													1.00
687					46.790								
688													
689	4	80							-17.872				1.00
690	4												
691					33.903				-0.000				1.00
692													
693													
694	4	75											1.00
695	4												
696					33.903	32.522		270.00					
697													
698													
699													
47													
700	4	74				30.100							1.00
701	4												
702													1.00
703													

227

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	**	*********	*********	*********	*********	*********	*********	*********	*********	*********	********	
					46.790				168.118					704
4	80												1.00	705
														706
4													1.00	707
														708
4					59.894				180.000					709
														710
4	75												1.00	711
														712
4					60.111	32.522		90.00					1.00	713
														714
														715
48														
						30.100								716
4	74												1.00	717
														718
4					46.790				-5.944				1.00	719
														720
4	80												1.00	721
														722
4					33.469				-0.000				1.00	723
														724
														725
4	75												1.00	726
														727
														728
4					33.252	32.522		270.00					1.00	729
														730
														731
49														
						30.100								732
4	74												1.00	733
														734
4					46.790				179.945				1.00	735
														736
4	80												1.00	737
														738
4					60.328				180.000				1.00	739
														740
4	75												1.00	741
														742
4					60.545	32.522		90.00					1.00	743
														744
														745
99	2													746
														747
														748
														749

228

3.4 <u>Original Boeing Tape - Ply 51 through Ply 144.</u>

** CH47FRB ROOT LOOP PLU 51 THRU 144 (ORIGINAL FROM BOEING) **   ATLAS CONTROL TAPE LIST   27-AUG-76   10:41:22   PAGE 1

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
0	90	62		0.000	0.000	35.000	0.000	180.00	-0.000				
		75		-317.777	46.790								
51		74		-303.805		25.000							
				-286.000		25.450							
	4			-293.000				359.99	180.000				1.00
	4	64		-298.500									5.00
	4	75		-304.237									1.00
	4	80		-307.000									1.00
	4	65		-317.777		25.000							
	4	74		-318.777		26.000							1.00
	4	75		-317.994		29.000		180.00					1.00
52		74		-303.805		25.000							
				-286.000		25.459							
	4			-293.000				359.99	0.000				1.00
	4	64		-298.500									5.00
	4	75		-304.454									1.00
	4	80											1.00
	4	65											

230

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
48													
49	74			-307.000									
50													
51	4			-317.994		25.000							1.00
52		75											
53	4			-318.994		26.000							1.00
54				-318.211		29.000							
55								180.00					
56													
53													
57	74			-303.805		25.000							
58				-286.000		25.468							
59													
60													
61	4			-293.000				359.99	180.000				1.00
62													
63													
64	64			-298.500									5.00
65	4	75											
66													
67	4	80		-304.671									1.00
68													
69	4	65											1.00
70													
71	4	74		-307.000		23.000							1.00
72													
73													
74	4	75		-318.211		23.000							1.00
75													
76				-319.211		26.000							
77				-318.428		29.000			180.00					
78													
79													
80													
81													
54													
82	74			-303.805		25.000							
83				-286.000		25.477							
84													
85													
86	4			-293.000				359.99	0.000				1.00
87													
88													
89	64			-298.500									5.00
90	4	75											
91													
92													
93													
94	4	80		-304.888									1.00
95													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
				*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
	65	4		-307.000									1.00
	74	4		-318.428		25.000							1.00
	75	4		-319.428		26.000							1.00
				-318.645		29.000		180.00					
55	74			-303.805		25.000							
				-286.000		25.486							
		4		-293.000				359.99	180.000				1.00
	64			-298.500									5.00
	75			-305.105									1.00
	80	4		-307.000									1.00
	65	4		-318.645		25.000							1.00
	74			-319.645		26.000							
	75	4		-318.862		29.000		180.00					
56	74			-303.805		25.000							
				-286.000		25.495							
		4		-293.000				359.99	0.000				1.00
	64			-298.500									
	75	4		-305.322									5.00

232

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	***	********	********	********	********	********	********	********	********	********	********	144
	4	80											1.00	145
	4	65		-307.000									1.00	146
														147
	4	74												148
														149
	4			-318.862		25.000							1.00	150
														151
														152
	4	75		-319.862		26.000								153
	4			-319.079		29.000		180.00					1.00	154
														155
														156
57		74		-303.805		25.000								157
				-286.000		25.504								158
														159
	4													160
				-293.000				359.99	180.000				1.00	161
														162
				-298.500										163
														164
													5.00	165
	4	64		-305.539										166
														167
	4	75												168
													1.00	169
	4	80		-307.000										170
													1.00	171
	4	65		-319.079										172
														173
	4	74		-320.079		26.000								174
													1.00	175
	4	75		-319.296		29.000		180.00						176
														177
													1.00	178
														179
														180
														181
58		74		-303.805		25.000								182
				-286.000		25.513								183
														184
	4			-293.000				359.99	0.000				1.00	185
														186
				-298.500										187
														188
														189
	4	64											5.00	190

233

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
			75										
	4			-305.756									1.00
		80											
	4		65	-307.000									1.00
			74										
	4			-319.296		25.000							1.00
			75										
	4			-320.296		26.000							1.00
				-319.719		29.000		180.00					
59													
			74	-303.805		25.000							
				-286.000		25.522							
	4			-293.000				359.99	180.000				1.00
				-298.500									
	4		64	-306.179									5.00
			75										
	4		80										1.00
	4		65	-307.000									1.00
			74										
	4			-319.719		25.000							1.00
			75										
	4			-320.719		26.000							1.00
				-320.142		29.000		180.00					
60													
			74	-303.805		25.000							
				-286.000		25.531							
	4			-293.000				359.99	0.000				1.00
				-298.500									

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			64										5.00	240
			4											241
			75	-306.602										242
														243
			4										1.00	244
			80											245
			4										1.00	246
			65	-307.000										247
			74											248
			4	-320.142		25.000							1.00	249
														250
			75	-321.142		26.000								251
			4	-320.565		29.000							1.00	252
														253
								180.00						254
														255
														256
61			74			25.000								257
				-303.805		25.540								258
				-286.000										259
			4										1.00	260
				-293.000				359.99	180.000					261
			4	-298.500										262
														263
			64										5.00	264
			75											265
			65	-307.000									1.00	266
			74											267
			4	-307.025		25.540							1.00	268
			80											269
			4	-320.565		25.000							1.00	270
			75											271
			4	-321.565		26.000							1.00	272
				-320.988		29.000								273
								180.00						274
														275
														276
														277
														278
														279
														280
														281
														282
62			74			25.000								283
				-303.805		25.549								284
				-286.000										285
														286
			4										1.00	287

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	***	***	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
288				-293.000					0.000				
289													
290	4	64		-298.500				359.99					5.00
291													
292	4	75		-307.000									1.00
293													
294													
295	4	65											1.00
296													
297	4	74											1.00
298													
299	4			-307.488		25.549							
300		80											1.00
301													
302	4			-320.988		25.000							1.00
303		75											
304													
305													
306	4			-321.988		26.000							1.00
307				-321.411		29.000		180.00					
308													
63													
309				-303.805		25.000							
310	4	74		-286.000		25.558							
311													
312													
313													
314	4			-293.000				359.99	180.000				1.00
315													
316	4	64		-298.500									
317													
318	4	75											5.00
319													
320													
321	4	65		-307.000									1.00
322													
323	4	74											1.00
324													
325	4			-307.871		25.551							1.00
326													
327		80											
328	4			-321.411		25.000							1.00
329		75											
330													
331	4			-322.411		26.000							1.00
332				-321.834		29.000		180.00					

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	***	**	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
64			74			25.000							
				-303.805		25.567							
				-286.000									
	4			-293.000									1.00
								359.99	0.000				
				-298.500									
			64										
	4		75										5.00
				-307.000									
	4		65										1.00
	4		74										1.00
	4					25.525							1.00
			80	-308.294									
	4					25.000							1.00
			75	-321.834									
	4					26.000		180.00					1.00
				-322.834		29.000							
				-322.257									
65			74			25.000							
				-303.805		25.576							
				-286.000									
	4			-293.000				359.99	180.000				1.00
				-298.500									
			64										
	4		75										5.00
				-307.000									
	4		65										1.00
	4		74										1.00
	4			-308.717		25.521							1.00
			80										
	4		75	-322.257		25.000							1.00

335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382

Line	N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
	***	**	***	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
383		4												1.00
384					-323.257		26.000							
385							29.000							
386					-322.680				180.00					
387	66						25.000							
388			74		-303.805		25.585							
389					-286.000									
390														
391		4			-293.000									1.00
392									359.99					
393										0.000				
394					-298.500									
395			64											5.00
396														
397			75		-307.000									
398														1.00
399		4	65											
400		4	74											1.00
401														
402														
403		4												1.00
404			80		-309.140		25.516							
405		4												1.00
406			75		-322.680		25.000							
407														
408		4												1.00
409					-323.680		26.000							
410							29.000							
411					-323.103				180.00					
412														
413	67						25.000							
414			74		-303.805		25.594							
415					-286.000									
416														
417		4			-293.000									1.00
418									359.99	180.000				
419														
420			64		-298.500									
421		4												5.00
422			75		-307.000									
423														
424		4	65											1.00
425														
426		4	74											1.00
427														
428		4			-309.563		25.524							1.00
429														
430														

238

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
	4	80												431
				-323.103		25.000							1.00	432
		75												433
	4			-324.103		26.000								434
						29.000							1.00	435
				-323.526				180.00						436
														437
														438
68														
		74				25.000								439
														440
				-303.805		25.603								441
		75		-286.000										442
														443
	4			-293.000				359.99	0.000				1.00	444
														445
		64		-298.500										446
	4													447
		75											5.00	448
	4													449
		65		-307.000										450
	4												1.00	451
		74												452
	4												1.00	453
														454
		80		-309.986		25.522							1.00	455
	4													456
		75												457
				-323.526		25.000							1.00	458
	4													459
				-324.526		26.000								460
				-323.949		29.000		180.00					1.00	461
														462
														463
														464
69														
		74				25.000								465
														466
				-303.805		25.612								467
	4			-286.000										468
														469
				-293.000				359.99	180.000				1.00	470
														471
	4													472
		64		-298.500										473
		75												474
	4												5.00	475
		65		-307.000										476
														477
														478

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
	4		74										1.00
	4			-310.409		25.519							1.00
	4		80	-323.949		25.000							1.00
	4		75	-324.949		26.000							
	4			-324.372		29.000		180.00					1.00
70													
	4		74			25.000							
	4			-303.805		25.621							
	4			-286.000									
	4			-293.000				359.99	0.000				1.00
	4		64	-298.500									
	4		75										5.00
	4		65	-307.000									1.00
	4		74										1.00
	4		80	-310.832		25.517							1.00
	4			-324.372		25.000							1.00
	4		75	-325.372		26.000							
	4			-324.795		29.000		180.00					
71													
	4		74			25.000							
	4			-303.805		25.630							
	4			-286.000									
	4			-293.000				359.99	180.000				1.00
	4		64	-298.500									5.00

Line numbers: 479 480 481 482 483 484 485 486 487 488 489 490 / 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 / 517 518 519 520 521 522 523 524 525 526

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			75											527
														528
	4			-307.000									1.00	529
			65											530
	4													531
			74											532
	4			-311.255		25.614							1.00	533
			80											534
	4													535
			75	-324.795		25.000							1.00	536
	4													537
				-325.795		26.000								538
	4			-329.295		29.000		180.00					1.00	539
														540
														541
														542
72														543
			74	-303.805		25.000								544
	4			-286.000		25.639								545
														546
	4			-293.000				359.99	0.000				1.00	547
			64	-298.500										548
	4													549
			75											550
	4			-307.000									5.00	551
			65											552
	4													553
			74											554
	4			-315.755		25.400							1.00	555
			80											556
	4													557
			75	-329.295		25.000							1.00	558
	4													559
				-330.295		26.000								560
	4			-329.860		29.000		180.00					1.00	561
														562
														563
														564
														565
														566
														567
														568
73														569
			74	-303.805		25.000								570
	4			-286.000		25.648								571
														572
	4			-293.000									1.00	573
														574

241

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
		64		-298.500				359.99	180.000					575
														576
														577
	4	75		-307.000									5.00	578
														579
														580
	4	65											1.00	581
														582
	4	74											1.00	583
														584
														585
		80		-315.320		25.394							1.00	586
														587
	4	75		-329.860		25.000							1.00	588
														589
	4			-330.860		26.000							1.00	590
				-330.405		29.000		180.00						591
														592
														593
														594
74		74				25.000								595
				-333.805		25.657								596
				-286.000										597
	4			-293.000				359.99	0.000				1.00	598
				-298.500										599
		64												600
	4	75											5.00	601
				-307.000										602
	4	65											1.00	603
	4	74											1.00	604
														605
	4			-316.865		25.260							1.00	606
		80												607
	4	75		-330.405		25.000							1.00	608
														609
	4			-331.405		26.000								610
				-330.970		29.000		180.00						611
														612
														613
														614
75		74		25.000		25.000								615
														621
														622

** CH47FRB ROOT LOOP PLU 51 THRU 144 (ORIGINAL FROM BOEING) **   ATLAS CONTROL TAPE LIST   27-AUG-76   10:41:22   PAGE   14

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
623				-303.805		25.666							
624				-286.000									
625	4												1.00
626				-293.000				359.99	180.000				
627				-298.500									
628													
629		64											
630		75											5.00
631													
632	4	65		-307.000									1.00
633													
634	4	74											1.00
635													
636													
637	4	80		-317.430		25.283							1.00
638													
639													
640	4	75		-330.970		25.000							1.00
641													
642													
643	4			-331.970		26.000							1.00
644				-331.525		29.000							
645													
646								180.00					
647	76	74		-303.805		25.000							
648				-286.000		25.675							
649		75											
650	4			-293.000				359.99	0.000				1.00
651													
652				-298.500									
653													
654		64											
655	4	75											5.00
656				-307.000									
657													
658	4	65											1.00
659													
660	4	74											1.00
661													
662													
663	4	80		-317.985		25.265							1.00
664													
665		75											
666	4			-331.525		25.000							1.00
667													
668													
669	4			-332.525		26.000							1.00
670						29.000							
671													

** CH47FRB ROOT LOOP PLU 51 THRU 144 (ORIGINAL FROM BOEING) **   ATLAS CONTROL TAPE LIST   27-AUG-76   10:41:22   PAGE   15

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	**********	**********	**********	**********	**********	**********	**********	**********	**********	********	
77				-332.080		25.000		180.00	180.00					672
	74			-303.805		25.684								673
				-286.000										674
														675
	4			-293.000									1.00	676
														677
				-298.500				359.99	180.000					678
														679
	64													680
	75												5.00	681
														682
	4			-307.000										683
	65												1.00	684
	4													685
	74												1.00	686
	4													687
														688
	80			-318.540		25.274							1.00	689
	4													690
														691
	75			-332.080		25.000							1.00	692
	4													693
				-333.080		26.000								694
				-332.635		29.000		180.00						695
														696
														697
														698
78				-303.805		25.000								699
	74			-286.000		25.693								700
														701
	4			-293.000				359.99	0.000				1.00	702
														703
				-298.500										704
	64													705
	75			-307.000									5.00	706
	4													707
	65												1.00	708
	4													709
	74												1.00	710
	4			-319.095		25.275							1.00	711
	80			-332.635		25.000							1.00	712
	4													713

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
				*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
720		75											1.00
721		4		-333.635		26.000							
722						29.000							
723				-333.190				180.00					
724						180.000							
725		79				23.000							
726		74											
727		4		-303.805		25.702							
728				-286.000									
729				-293.000									1.00
730				-298.500				359.99	180.000				
731													
732		64											
733													
734		75		-307.000									5.00
735		4											
736													
737		65											1.00
738		4											1.00
739		74											
740		4											1.00
741				-319.650		25.269							
742		80											
743		4											
744				-333.190		25.000							1.00
745		75											
746		4											
747				-334.190		26.000							1.00
748						29.000							
749				-333.745									
750						25.000		180.00					
751		80											
752		74		-303.805		25.711							
753		4		-286.000									
754				-293.000									1.00
755													
756				-298.500				359.99	0.000				
757													
758		64											
759		4											
760		75		-307.000									5.00
761		4											
762													
763		65											1.00
764		4											1.00
765		74											
766		4											1.00
767													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***		*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
		80		-320.205		25.263								768
													1.00	769
														770
	4		75	-333.745		25.000								771
														772
	4			-334.745		26.000								1.00	773
				-334.305		29.000									774
								180.00						775
														776
81		74		-303.805		25.000								777
				-285.000		25.720								778
														779
														780
	4			-293.000				359.99	180.000				1.00	781
														782
		64		-298.500										783
														784
	4	75		-307.000									5.00	785
														786
														787
	4	65		-320.765		25.257								788
														789
	4	74											1.00	790
				-334.305		25.000								791
	4	80											1.00	792
														793
	4	75		-335.305		26.000								1.00	794
				-334.930		29.000									795
	4							180.00						796
													1.00	797
														798
													1.00	799
														800
														801
														802
82		74		-303.805		25.000								803
				-286.000		25.729								804
														805
														806
	4			-293.000				359.99	0.000				1.00	807
														808
		64		-298.500										809
														810
	4	75											5.00	811
														812
	4			-307.000									1.00	813
														814
														815

246

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			65											816
	4												1.00	817
			74											818
	4												1.00	819
				-321.390		25.249								820
			80											821
	4												1.00	822
				-334.930		25.000								823
			75											824
	4												1.00	825
				-335.930		26.000								826
				-335.555		29.000								827
								180.00						828
83														829
				-303.805		25.000								830
			74	-286.000										831
	4													832
				-293.000		25.738							1.00	833
				-298.500				359.99	180.000					834
			64											835
			75											836
	4													837
													5.00	838
			65	-307.000										839
	4													840
													1.00	841
	4													842
													1.00	843
	4													844
													1.00	845
			80	-322.015		25.331								846
	4													847
													1.00	848
			75	-335.555		25.000								849
	4													850
				-336.555		26.000							1.00	851
														852
				-336.180		29.000		180.00						853
														854
84														855
			74	-303.805		25.000								856
	4			-286.000		25.740								857
														858
				-293.000				359.99	0.000					859
													1.00	860
				-298.500										861
														862
			64											863

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
84	75		4	-307.000									5.00
	65		4										1.00
	74		4										1.00
			4										1.00
	80		4	-322.640		25.319							1.00
	75		4	-336.180		25.000							1.00
			4	-337.180		26.000							
				-336.805		29.000		180.00					
85	74		4	-303.805		25.000							
				-286.000									
			4	-293.000		25.747		359.99	180.000				1.00
	64			-298.500									
	75		4	-307.000									5.00
	65		4	-323.265		25.312							1.00
	74		4	-336.805		25.000							1.00
	80		4	-337.805		26.000							1.00
	75		4	-337.430		29.000		180.00					
86	74		4	-303.805		25.000							
				-286.000		25.756							1.00

864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911

** CH47FRB ROOT LOOP PLU 51 THRU 144 (ORIGINAL FROM BOEING) **   ATLAS CONTROL TAPE LIST 27-AUG-76 10:41:22 PAGE 20

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
***	**	**	***	*********	**********	*********	**********	*********	*********	**********	**********	*********	*********
912				-293.000				359.99	0.000				
913	64			-298.500									5.00
914													
915	75					25.000							
916	4			-307.000									1.00
917													
918	65												
919	4												1.00
920	74												
921	4			-323.890		25.306							
922													
923													1.00
924	80												
925	4			-337.430		25.000							
926	75												1.00
927	4												
928				-338.430		26.000							
929				-338.055		29.000							
930								180.00					1.00
931													
932													
933						25.000							
934	74			-303.805		25.765							
935				-286.000									
936	4												1.00
937				-293.000				359.99	180.000				
938													
939													
940				-298.500									5.00
941	64												
942	75												
943	4			-307.000									1.00
944													
945	65												
946	4												1.00
947	74												
948	4												1.00
949				-324.515		25.302							
950	80												
951				-338.055		25.000							
952	4												1.00
953	75												
954				-339.055		26.000							
955	4												
956				-353.680		29.000		180.00					
957													
958													

87

N	G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	Line
****	** ***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
88												959
	74			25.000								960
		-303.805										961
		-286.000		25.774							1.00	962
	4											963
		-293.000				359.99	0.000					964
		-298.500										965
	64											966
	75										5.00	967
												968
	65	-307.000										969
											1.00	970
	4											971
	74										1.00	972
	4											973
											1.00	974
	80											975
	4	-325.140		25.296								976
											1.00	977
	75			25.000								978
		-338.680										979
	4											980
											1.00	981
		-339.680		26.000								982
		-339.305		29.000		180.00						983
												984
89												985
	74			25.000								986
		-303.805										987
		-286.000		25.783								988
	4											989
		-293.000				359.99	180.000				1.00	990
		-298.500										991
	64											992
	75											993
											5.00	994
	65	-307.000										995
											1.00	996
	4											997
	74										1.00	998
	4											999
											1.00	1000
	80											1001
	4	-325.765		25.292								1002
												1003
	75	-339.305									1.00	1004
				25.000								1005
												1006

250

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
1007	4												1.00
1008				-340.305		26.000							
1009				-339.759		29.000			180.00					
1010								180.00					
1011			90			25.000							
1012			74										
1013				-303.805									
1014				-286.000		25.792							
1015													
1016	4			-293.000									1.00
1017								359.99	0.000				
1018				-298.500									
1019			64										
1020	4		75										5.00
1021				-307.000									
1022	4		65										1.00
1023	4		74										
1024	4												1.00
1025													
1026	4												1.00
1027			80	-326.219		25.290							
1028	4												
1029				-339.759		25.000							1.00
1030	4		75										
1031													
1032													
1033	4												1.00
1034				-340.759		26.000							
1035				-340.213		29.000							
1036								180.00					
1037			16			25.000							
1038			74	-303.805		25.801							
1039				-286.000									
1040													
1041	4			-293.000									1.00
1042								359.99	180.000				
1043													
1044			64	-298.500									
1045	4												5.00
1046													
1047			75	-307.000									
1048	4												
1049			65										1.00
1050	4												
1051			74										1.00
1052	4												
1053				-326.673		25.289							1.00
1054													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
		80												1055
	4			-340.213		25.000							1.00	1056
		75												1057
	4			-341.213		26.000								1058
				-340.667		29.000		180.00					1.00	1059
														1060
														1061
														1062
92		74				25.000								1063
				-303.805		25.810								1064
				-286.000										1065
	4			-293.000				359.99	0.000				1.00	1066
				-298.500										1067
		64												1068
	4	75		-307.000									5.00	1069
	4	65											1.00	1070
	4	74											1.00	1071
	4	80		-327.127		25.288							1.00	1072
	4	75		-340.667		25.000							1.00	1073
	4			-341.667		26.000								1074
				-341.121		29.000		180.00					1.00	1075
93		74				25.000								1089
				-303.805		25.819								1090
				-286.000										1091
	4			-293.000				359.99	180.000				1.00	1092
				-298.500										1093
	4	64											5.00	1094
	4	75		-307.000										1095
	4	65											1.00	1096

* * CH47FRB ROOT LOOP PLU 51 THRU 144 (ORIGINAL FROM BOEING) * *   ATLAS CONTROL TAPE LIST   27-AUG-76   10:41:22   PAGE 24

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
	4		74										1.00	1103
														1104
	4		80	-327.581		25.287							1.00	1105
														1106
														1107
	4		75	-341.121		25.000							1.00	1108
														1109
														1110
	4			-342.121		26.000							1.00	1111
														1112
														1113
				-341.575		29.000		180.00						1114
--														
94						25.000								1115
	4		74	-303.805		25.828								1116
				-286.000										1117
														1118
	4			-293.000				359.99	0.000				1.00	1119
														1120
														1121
	4		64	-298.500										1122
														1123
	4		75										5.00	1124
														1125
														1126
	4		65	-307.000									1.00	1127
														1128
	4		74										1.00	1129
														1130
	4			-328.035		25.279							1.00	1131
														1132
	4		80											1133
				-341.575		25.000							1.00	1134
														1135
	4		75											1136
				-342.575		26.000							1.00	1137
														1138
				-342.029		29.000								1139
									180.00						1140
--														
95						25.000								1141
	4		74	-303.805		25.837								1142
				-286.000										1143
														1144

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	Line
****	**	***	**	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
			75	-307.000										1151
														1152
	4		65										1.00	1153
														1154
	4		74										1.00	1155
														1156
	4			-328.489		25.285							1.00	1157
			80	-342.029		25.000								1158
														1159
	4												1.00	1160
														1161
			75	-343.029		26.000								1162
	4			-342.483		29.000		180.00						1163
														1164
														1165
														1166
96			74			25.000								1167
				-303.805		25.846								1168
				-286.000										1169
	4												1.00	1170
														1171
				-293.000				359.99	0.000					1172
														1173
				-298.500										1174
														1175
	4		64										5.00	1176
			75	-307.000										1177
														1178
	4		65										1.00	1179
	4		74											1180
														1181
	4												1.00	1182
				-328.943		25.283								1183
			80											1184
	4												1.00	1185
				-342.483		25.000								1186
			75											1187
	4			-343.483		26.000							1.00	1188
														1189
				-342.937		29.000		180.00						1190
														1191
														1192
97			74			25.000								1193
				-303.805		25.855								1194
				-286.000										1195
														1196
	4			-293.000										1.00	1197
														1198

254

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
98			64	-298.500				359.99	180.000				
		4	75										5.00
				-307.000									
		4	65										1.00
		4	74										1.00
				-329.397		25.282							
		4	80										1.00
				-342.937		25.000							
		4	75										1.00
				-343.937		26.000							
				-343.391		29.000		180.00					
		4	75										1.00
98			74	-303.805		25.000							
				-286.000		25.864							
		4											1.00
				-293.000				359.99	0.000				
				-298.500									
		4	75	-307.000									5.00
		4	65										1.00
		4	74										1.00
				-329.851		25.281							
		4	80										1.00
				-343.391		25.000							
		4	75										1.00
				-344.391		26.000							
				-343.845		29.000		180.00					
99			74	25.000									

1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246

255

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
1247				-303.805		25.873							
1248				-286.000									
1249	4												
1250				-293.000						180.000			1.00
1251								359.99					
1252				-298.500									
1253			64										
1254	4		75										5.00
1255													
1256													
1257	4			-307.000									
1258	4		65										1.00
1259	4		74										1.00
1260													
1261	4												1.00
1262			80	-330.305		25.280							
1263													
1264	4		75	-343.845		25.000							1.00
1265													
1266													
1267	4			-344.845		26.000							1.00
1268						29.000							
1269													
1270				-344.305				180.00					
1271	100		74	-303.805		25.000							
1272				-286.000		25.882							
1273													
1274	4			-293.000									
1275								359.99		0.000			1.00
1276				-298.500									
1277													
1278													
1279			64										
1280	4		75										5.00
1281													
1282	4			-307.000									
1283	4		65										1.00
1284	4		74										1.00
1285													
1286													
1287	4												1.00
1288			80	-330.765		25.279							
1289													
1290	4		75	-344.305		25.000							1.00
1291													
1292													
1293	4			-345.305		26.000							
1294						29.000							
1295													

256

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
101				-344.941	-344.941	25.000		180.00						1296
			74	-303.805		25.89?								1297
				-286.000										1298
														1299
													1.00	1300
		4		-293.000				359.99	180.000					1301
														1302
				-298.500										1303
			64											1304
													5.00	1305
		4	75	-307.000										1306
														1307
		4	65										1.00	1308
														1309
		4	74										1.00	1310
														1311
		4											1.00	1312
														1313
			80	-331.401		25.273								1314
														1315
		4		-344.941		25.000							1.00	1316
														1317
			75											1318
		4		-345.941		26.000							1.00	1319
				-345.577		29.000								1320
														1321
									180.00					1322
102				-303.805		25.000								1323
			74	-286.000		25.900								1324
														1325
														1326
														1327
		4		-293.000				359.99	0.000				1.00	1328
														1329
				-296.500										1330
			64											1331
													5.00	1332
		4	75	-307.000										1333
														1334
		4	65										1.00	1335
														1336
		4	74										1.00	1337
														1338
		4		-332.037		25.268							1.00	1339
			80											1340
														1341
		4		-345.577		25.000							1.00	1342
														1343

257

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
			73										1.00	1344
			4	-346.577		26.000								1345
				-346.213		29.000		180.00						1346
														1347
														1348
103														1349
			74											1350
				-303.805		25.000								1351
				-286.000		25.909								1352
			4										1.00	1353
				-293.000				359.99	180.000					1354
				-298.500										1355
														1356
			64										5.00	1357
			75											1358
				-307.000										1359
														1360
			65										1.00	1361
			74										1.00	1362
			4											1363
													1.00	1364
			4											1365
			80	-332.673		25.300								1366
			4										1.00	1367
			73											1368
			4	-346.213		25.000								1369
														1370
			4										1.00	1371
				-347.213		26.000								1372
				-346.849		29.000		180.00						1373
														1374
104														1375
			74			25.000								1376
				-303.805		25.918								1377
				-286.000										1378
			4	-293.000				359.99	0.000					1379
													1.00	1380
														1381
			64	-298.500										1382
			75											1383
													5.00	1384
			4	-307.000										1385
			65											1386
			4										1.00	1387
			74											1388
													1.00	1389
			4											1390
													1.00	1391

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
	80			-333.309		25.295								1392
			4										1.00	1393
				-346.849		25.000								1394
	75													1395
			4										1.00	1396
				-347.849		26.000								1397
			4			29.000								1398
				-347.485										1399
								180.00						1400
105	74					25.000								1401
			4										1.00	1402
				-303.805		25.927								1403
				-286.000										1404
														1405
			4	-293.000				359.99	180.000					1406
				-298.500										1407
	64													1408
														1409
	75		4			25.291							5.00	1410
														1411
	65		4	-307.000									1.00	1412
														1413
	74		4										1.00	1414
														1415
														1416
			4	-333.945		25.291							1.00	1417
														1418
	80													1419
			4	-347.485		25.000							1.00	1420
	75													1421
			4										1.00	1422
				-348.485		26.000								1423
				-348.121		29.000								1424
								180.00						1425
														1426
106	74					25.000								1427
			4										1.00	1428
				-303.805		25.936								1429
				-286.000										1430
														1431
			4	-293.000				359.99	0.000					1432
				-298.500										1433
	64													1434
			4										5.00	1435
	75													1436
				-307.000										1437
			4										1.00	1438
														1439

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
		65												1440
	4												1.00	1441
	4													1442
		74											1.00	1443
				-334.581		25.286								1444
		80											1.00	1445
				-348.121		25.000								1446
		75											1.00	1447
	4													1448
				-349.121		26.000								1449
				-348.757		29.000		180.00						1450
														1451
														1452
107		74				25.000								1453
				-303.805		25.945								1454
				-286.000										1455
	4												1.00	1456
														1457
				-293.000				359.99	180.000					1458
									180.000					1459
		64		-298.500										1460
	4													1461
		75											5.00	1462
	4													1463
		65		-307.000									1.00	1464
	4													1465
		74											1.00	1466
	4													1467
													1.00	1468
		80		-335.217		25.282								1469
	4												1.00	1470
		75		-348.757		25.000								1471
	4													1472
				-349.757		26.000							1.00	1473
				-349.393		29.000		180.00						1474
														1475
														1476
														1477
														1478
108		74				25.000								1479
				-303.805		25.954								1480
				-286.000										1481
	4													1482
													1.00	1483
				-293.000				359.99	0.000					1484
														1485
		64		-296.500										1486
														1487

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	1488
													5.00	1489
4			75	-307.000										1490
													1.00	1491
4			65											1492
4			74										1.00	1493
4				-335.853		25.278								1494
													1.00	1495
4			80	-349.393		25.000								1496
													1.00	1497
4			75	-350.393		26.000								1498
				-350.029		29.000								1499
								180.00					1.00	1500
														1501
														1502
														1503
														1504
109			74			25.000								1505
4				-303.805		25.963								1506
				-286.000										1507
														1508
4				-293.000									1.00	1509
														1510
														1511
4			64	-298.500				359.99	180.000					1512
														1513
4			75	-307.000									5.00	1514
														1515
4			65										1.00	1516
4														1517
4			74										1.00	1518
														1519
														1520
4			80	-336.489		25.273							1.00	1521
														1522
4			65	-350.029		25.000								1523
													1.00	1524
4			75	-351.029		26.000								1525
				-350.665		29.000								1526
								180.00					1.00	1527
														1528
														1529
														1530
110						25.000								1531
4			74	-303.805		25.972								1532
				-286.000										1533
														1534
4													1.00	1535

261

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
1536				-293.000				359.99	0.000				
1537													
1538													
1539		64		-298.500									5.00
1540													
1541	4	75		-307.000									
1542													1.00
1543	4	65											
1544	4	74											
1545													
1546													1.00
1547		80		-337.125		25.269							
1548													1.00
1549	4	75		-350.665		25.000							
1550													
1551													1.00
1552	4			-351.665		26.000							
1553				-351.305		29.000		180.00					
1554													
1555													
1556													
1557	111	74		-303.805		25.000							1.00
1558				-286.000		25.981							
1559													
1560	4			-293.000									
1561		75		-298.500									
1562													
1563								359.99	180.000				
1564	4	64		-307.000									
1565													
1566	4	75											5.00
1567													
1568	4	65											1.00
1569													
1570	4	74											1.00
1571													
1572													1.00
1573		80		-337.765		25.264							
1574													1.00
1575	4	75		-351.305		25.000							
1576													
1577													1.00
1578	4			-352.305		26.000							
1579													
1580				-354.638		29.000		180.00					
1581													
1582													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
112														1583
			74			25.000								1584
				-303.805		25.990								1585
				-286.000										1586
	4			-293.000				359.99	0.000				1.00	1587
				-298.500										1588
			64										5.00	1589
			75	-307.000										1590
	4												1.00	1591
	4												1.00	1592
	4												1.00	1593
			80	-341.098		25.204								1594
	4			-354.638		25.000							1.00	1595
			75											1596
	4			-355.638		26.000							1.00	1597
				-357.971		29.000		180.00						1598
113														1609
			74			25.000								1610
				-303.805		25.999								1611
				-286.000										1612
	4			-293.000				359.99	180.000				1.00	1613
				-298.500										1614
			64										5.00	1615
			75	-307.000										1616
	4		65										1.00	1617
	4		74										1.00	1618
	4												1.00	1619
			80	-344.431		25.141								1620
			75	-357.971		25.000							1.00	1621

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
4				-358.971		26.000							1.00	1631
						29.000								1632
				-361.304				180.00						1633
														1634
114														
		74				25.000								1635
				-303.805		26.008								1636
				-286.000										1637
													1.00	1638
4				-293.000				359.99	0.000					1639
														1640
														1641
		64		-298.500		25.000							5.00	1642
														1643
4		75												1644
				-307.000									1.00	1645
4		65												1646
4		74											1.00	1647
														1648
4													1.00	1649
														1650
				-347.764		25.000								1651
		80												1652
														1653
4				-361.304		25.000							1.00	1654
		75												1655
														1656
4				-362.304		26.000							1.00	1657
						29.000								1658
				-364.637				180.00						1659
														1660
115														
		74				25.000								1661
				-303.805		26.017								1662
				-286.000										1663
4														1664
													1.00	1665
				-293.000				359.99	180.000					1666
														1667
														1668
		64		-298.500										1669
4		75											5.00	1670
														1671
4		65												1672
				-307.000									1.00	1673
4		74											1.00	1674
														1675
														1676
4													1.00	1677
				-351.097		25.070								1678

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	***	********	********	********	********	********	********	********	********	********	********	
			80											1679
	4			-364.637		25.000							1.00	1680
														1681
			75											1682
	4			-365.637		26.000							1.00	1683
				-367.970		29.000								1634
														1685
								180.00						1686
116			74			25.000								1687
				-303.805										1688
				-286.000		26.026								1689
														1690
	4			-293.000									1.00	1691
								359.99	0.000					1692
														1693
			64	-298.500										1694
	4												5.00	1695
														1696
			75	-307.000										1697
	4		65										1.00	1698
														1699
	4		74										1.00	1700
														1701
	4												1.00	1702
			80	-354.430		25.060								1703
														1704
	4		75	-367.970		25.000							1.00	1705
														1706
			75											1707
	4			-368.970		26.000							1.00	1708
														1709
				-371.303		29.000		180.00						1710
														1711
														1712
117			74			25.000								1713
				-303.805										1714
				-286.000		26.035								1715
														1716
	4			-293.000									1.00	1717
								359.99	180.000					1718
														1719
			64	-298.500										1720
	4												5.00	1721
														1722
			75	-307.000										1723
	4		65										1.00	1724
														1725
														1726

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
				*********	*********	*********	*********	*********	*********	**********	**********	**********	**********
1727	4		74										
1728													1.00
1729	4		80	-357.803		25.050							
1730													1.00
1731													
1732	4			-371.303		25.000							
1733													1.00
1734			75										
1735	4			-372.303		26.000							
1736													1.00
1737													
1738				-374.636		29.000		180.00					
118													
1739			74	-303.805		25.000							
1740				-286.000		26.044							
1741													
1742													
1743	4			-293.000									1.00
1744				-298.500				359.99	0.000				
1745													
1746													
1747			64										
1748	4												5.00
1749			75	-307.000									
1750	4												
1751													
1752	4		65										1.00
1753													
1754	4		74										1.00
1755				-360.096		25.040							
1756	4		80										1.00
1757													
1758				-374.636		25.000							
1759	4		75										1.00
1760													
1761	4			-375.636		26.000							1.00
1762													
1763				-377.969		29.000		180.00					
1764													
119													
1765			74	-303.805		25.000							
1766													
1767				-286.000		26.053							
1768													
1769	4			-293.000									1.00
1770													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	1775
			75	-307.000										1776
	4		65										1.00	1777
														1778
	4		74										1.00	1779
														1780
	4					25.035							1.00	1781
			80	-364.429										1782
														1783
	4					25.000							1.00	1784
			75	-377.969										1785
														1786
	4					26.000							1.00	1787
				-378.969		29.000								1788
				-381.302				180.00						1789
														1790
120						25.000								1791
			74	-303.805										1792
				-286.000		26.062								1793
														1794
	4			-293.000									1.00	1795
								359.99	0.000					1796
				-298.500										1797
														1798
	4		64											1799
			75	-307.000									5.00	1800
														1801
	4		65										1.00	1802
														1803
	4		74										1.00	1804
														1805
	4					25.030							1.00	1806
			80	-367.762										1807
														1808
	4					25.000							1.00	1809
			75	-381.302										1810
														1811
	4					26.000							1.00	1812
				-382.302		29.000								1813
				-384.635				180.00						1814
														1815
														1816
121			74			25.000								1817
														1818

267

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
122								359.99	180.000					1823
			64	-298.500										1824
														1825
	4		75	-307.000									5.00	1826
														1827
	4		65										1.00	1828
														1829
	4		74										1.00	1830
														1831
				-371.095		25.025								1832
			80										1.00	1833
	4			-384.635		25.000								1834
														1835
			75										1.00	1836
														1837
	4			-385.635		26.000								1838
				-387.968		29.000								1839
														1840
								180.00						1841
														1842
122						25.000								1843
			74	-303.805										1844
				-286.000		26.080								1845
														1846
	4			-293.000									1.00	1847
														1848
				-298.500				359.99	0.000					1849
														1850
	4		64										5.00	1851
														1852
	4		75	-307.000										1853
														1854
	4		65										1.00	1855
														1856
	4		74										1.00	1857
														1858
				-374.428		25.020								1859
			80										1.00	1860
	4					25.000								1861
														1862
			75	-387.968									1.00	1863
														1864
	4			-388.968		26.000								1865
				-391.301		29.000								1866
														1867
								180.00						1868
123						25.000								1869
			74											1870

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
1871				-303.805		26.089							
1872	4			-286.000									1.00
1873													
1874				-293.000				359.99	180.000				
1875													
1876				-298.500									5.00
1877			64										
1878													
1879	4		75	-307.000									1.00
1880													
1881	4		65										1.00
1882													
1883	4		74										1.00
1884													
1885	4			-377.761		25.015							1.00
1886			80										
1887													
1888	4			-391.301		25.000							1.00
1889													
1890			75										
1891	4			-392.301		26.000							1.00
1892													
1893				-393.055		29.000							
1894								180.00					
1895			74	-303.805		25.000							
1896				-286.000		26.098							
1897													
1898													
1899	4			-293.000				359.99	0.000				1.00
1900													
1901				-298.500									5.00
1902			64										
1903	4		75	-307.000									1.00
1904													
1905	4		65										1.00
1906													
1907	4		74										1.00
1908													
1909	4			-379.515		25.010							1.00
1910			80										
1911													
1912	4			-393.055		25.000							
1913													
1914			75										
1915	4			-394.055		26.000							1.00
1916													
1917						29.000							
1918													
1919													

124

** CH4FRB ROOT LOOP PLU 51 THRU 144 (ORIGINAL FROM BOEING) **   ATLAS CONTROL TAPE LIST 27-AUG-76   10:41:22   PAGE 41

N G M S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
125	-394.805		25.000		180.00						1920
74											1921
	-303.805		26.107								1922
	-286.000										1923
4											1924
	-293.000									1.00	1925
					359.99	180.000					1926
	-298.500										1927
											1928
64											1929
4										5.00	1930
75	-307.000										1931
											1932
4										1.00	1933
4											1934
74										1.00	1935
4											1936
										1.00	1937
80	-381.265		25.005								1938
											1939
4										1.00	1940
75	-394.805		25.000								1941
											1942
4										1.00	1943
	-395.805		26.000								1944
	-396.555		29.000								1945
					180.00						1946
126			25.000								1947
74	-303.805		26.116								1948
	-286.000										1949
											1950
4	-293.000									1.00	1951
					359.99	0.000					1952
	-298.500										1953
											1954
64											1955
4										5.00	1956
75	-307.000										1957
											1958
4										1.00	1959
4										1.00	1960
74											1961
4										1.00	1962
	-383.015		25.000								1963
80											1964
4										1.00	1965
	-396.555		25.000								1966
											1967

270

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
1968			75										1.00
1969				-397.555		26.000							
1970	4			-398.305		29.000		130.00					
1971													
1972													
127													
1973						25.000							
1974			74	-303.805		26.125							
1975				-286.000									
1976													
1977	4			-293.000				359.99	180.000				1.00
1978													
1979				-298.500									
1980													
1981			64										
1982	4		75										5.00
1983													
1984													
1985	4			-307.000									1.00
1986													
1987	4		74										1.00
1988													
1989	4			-384.765		25.000							
1990			80										1.00
1991													
1992	4			-398.305		25.000							1.00
1993			75										
1994													
1995	4			-399.305		26.000							1.00
1996													
1997				-408.305		29.000		180.00					
1998													
128													
1999						25.000							
2000			74	-303.805		26.134							
2001				-286.000									
2002													
2003													
2004	4			-293.000				359.99	0.000				1.00
2005													
2006													
2007			64	-298.500									5.00
2008	4		75										
2009													
2010													
2011	4		65	-307.000									1.00
2012	4		74										1.00
2013													
2014	4												1.00
2015													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
			80	-394.765		25.000							1.00	2016 / 2017
	4		75	-408.305		25.000							1.00	2018–2021
	4			-409.305		26.000								2022
	4			-408.305		29.000		180.00						2023 / 2024
129			74	-303.805		25.000								2025 / 2026
				-286.000		26.143								2027 / 2028
	4			-293.000				359.99	180.000				1.00	2029 / 2030
	4			-298.500										2031 / 2032
	4		64										5.00	2033 / 2034
	4		75	-307.000									1.00	2035 / 2036
	4		65										1.00	2037 / 2038
	4		74										1.00	2039 / 2040
	4			-394.765		25.000							1.00	2041 / 2042
	4		80	-408.305		25.000							1.00	2043–2046
	4		75	-409.305		26.000							1.00	2047–2049
	4			-408.305		29.000		180.00						2050
130			74	-303.805		25.000								2051 / 2052
				-286.000		26.152								2053 / 2054
	4			-293.000				359.99	0.000				1.00	2055 / 2056
	4			-298.500										2057 / 2058
	4		64										5.00	2059 / 2060
	4		75	-307.000										2061 / 2062
	4												1.00	2063

272

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	***	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	2064
	4	65											1.00	2065
														2066
	4	74		-394.765		25.018							1.00	2067
														2068
														2069
	4	80		-408.305		25.018								2070
														2071
	4	75		-409.305		26.000							1.00	2072
														2073
	4			-408.305		29.000		180.00						2074
														2075
														2076
131														2077
		74		-303.805		25.000								2078
				-286.000		26.161								2079
														2080
	4			-293.000				359.99	180.000				1.00	2081
														2082
				-298.500									5.00	2083
	4	64												2084
	4	75												2085
				-307.000									1.00	2086
	4	65											1.00	2087
														2088
	4	74											1.00	2089
														2090
														2091
	4			-394.765		25.027							1.00	2092
														2093
	4	80		-408.305		25.027								2094
														2095
	4	75		-409.305		26.000							1.00	2096
														2097
	4			-408.305		29.000		180.00						2098
														2099
														2100
														2101
														2102
132														2103
		74		-303.805		25.000								2104
				-286.000		26.170								2105
														2106
	4			-293.000				359.99	0.000				1.00	2107
														2108
				-298.500										2109
		64												2110
														2111

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
2016				-394.765		25.000							
2017			80										
2018	4												1.00
2019				-408.305		25.000							
2020			75										
2021	4												1.00
2022													
2023				-409.305		26.000							
2024				-408.305		29.000		180.00					
129													
2025			74	-303.805		25.000							
2026				-286.000		26.143							
2027													
2028	4												
2029				-293.000									
2030								359.99	180.000				1.00
2031				-298.500									
2032													
2033			64										
2034	4												5.00
2035			75										
2036				-307.000									
2037	4												1.00
2038			65										
2039	4												1.00
2040			74										
2041				-394.765		25.000							
2042			80										1.00
2043	4												
2044				-408.305		25.000							
2045			75										1.00
2046													
2047	4												
2048				-409.305		26.000							
2049				-408.305		29.000		180.00					
2050													
130													
2051			74	-303.805		25.000							
2052				-286.000		26.152							
2053													
2054													
2055	4			-293.000									1.00
2056													
2057								359.99	0.000				
2058				-298.500									
2059			64										5.00
2060	4												
2061			75										
2062													
2063	4			-307.000									1.00

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	***	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	********	
	65	4												2064
	74	4											1.00	2065
		4												2066
													1.00	2067
	80			-394.765		25.018								2068
		4												2069
													1.00	2070
	75			-408.305		25.018								2071
		4												2072
													1.00	2073
		4		-409.305		26.000								2074
				-408.305		29.000		180.00						2075
														2076
131						25.000								2077
	74			-303.805		26.161								2078
				-286.000										2079
		4												2080
				-293.000				359.99	180.000				1.00	2081
														2082
				-298.500										2083
	64	4												2084
	75			-307.000									5.00	2085
		4												2086
	65	4												2087
	74	4												2088
		4											1.00	2089
														2090
													1.00	2091
	80			-394.765		25.027								2092
		4												2093
													1.00	2094
	75			-408.305		25.027								2095
		4												2096
													1.00	2097
		4		-409.305		26.000								2098
				-408.305		29.000		180.00						2099
														2100
														2101
														2102
132						25.000								2103
	74			-303.805		26.170								2104
				-286.000										2105
		4												2106
				-293.000				359.99	0.000				1.00	2107
														2108
				-298.500										2109
	64													2110
														2111

273

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
	4		75							*********	*********	*********	5.00
				-307.000									1.00
	4		65										
													1.00
	4		74										
													1.00
	4			-394.765		25.036							
			80										1.00
	4			-408.305		25.036							
	4		75										1.00
	4			-409.305		26.000							
				-408.305		29.000		180.00					
133													
	4		74			25.000							
				-303.805									
				-286.000		26.179							
	4			-293.000									1.00
				-298.500				359.99	180.000				
	4		64										5.00
	4		75	-307.000									
	4		65										1.00
	4		74										1.00
	4		80	-394.765		25.045							1.00
	4		75	-408.305		25.045							
													1.00
	4			-409.305		26.000							1.00
				-408.305		29.000							
								180.00					
134													
	4		74			25.000							
				-363.805									
				-286.000		26.188							
	4												1.00

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
****	***	**	***	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
2160				-293.000									
2161													
2162		4	64	-298.500				359.99	0.000				
2163													5.00
2164		4	75										
2165													
2166		4	65	-307.000									1.00
2167													
2168		4	74										1.00
2169													
2170		4	80										1.00
2171				-394.765		25.054							
2172													
2173		4	75										1.00
2174				-408.305		25.054							
2175													
2176		4											1.00
2177				-409.305		26.000							
2178				-408.305		29.000							
2179								180.00					
2180													

135

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE
2181			74	-303.805		25.000							
2182				-286.000		26.197							
2183													
2184		4		-293.000									1.00
2185													
2186				-298.500				359.99	180.000				
2187													
2188		4	64										5.00
2189													
2190		4	75	-307.000									
2191													
2192		4	65										1.00
2193													
2194		4	74										1.00
2195				-394.765		25.063							
2196													
2197		4	80										1.00
2198				-408.305		25.063							
2199													
2200		4	75										1.00
2201				-409.305		26.000							
2202				-408.305		29.000		180.00					
2203													
2204													
2205													
2206													

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
136														2207
	74					25.000								2208
				-303.805		26.206								2209
		4		-286.000										2210
														2211
				-293.000				359.99	0.000				1.00	2212
														2213
				-296.500										2214
		4	64											2215
													5.00	2216
														2217
		4	75	-307.000										2218
													1.00	2219
		4	65											2220
													1.00	2221
		4	74											2222
				-394.765		25.072							1.00	2223
			80											2224
														2225
		4	75	-408.305		25.072							1.00	2226
														2227
														2228
		4		-409.305		26.000							1.00	2229
														2230
				-408.305		29.000		180.00						2231
														2232
137														2233
	74					25.000								2234
				-303.805		26.215								2235
		4		-286.000										2236
														2237
				-293.000				359.99	180.000				1.00	2238
														2239
				-298.500										2240
		4	64											2241
													5.00	2242
		4	75	-307.000										2243
														2244
		4	65										1.00	2245
														2246
		4	74										1.00	2247
														2248
				-394.765		25.081							1.00	2249
			80											2250
														2251
		4		-408.305		25.081								2252
			75										1.00	2253
														2254

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	
	4												1.00	2255
				-409.305		26.000								2256
				-408.305		29.000		180.00						2257
														2258
138														
						25.000								2259
			74	-303.805		26.224								2260
				-286.000										2261
														2262
	4			-293.000				359.99	0.000				1.00	2263
				-298.500										2264
														2265
														2266
	4		64										5.00	2267
														2268
	4		75	-307.000									1.00	2269
														2270
	4		65										1.00	2271
														2272
	4		74										1.00	2273
														2274
														2275
	4		80	-394.765		25.090							1.00	2276
														2277
														2278
	4		75	-408.305		25.090							1.00	2279
														2280
														2281
	4			-409.305		26.000								2282
				-408.305		29.000		180.00						2283
														2284
139														
						25.000								2285
			74	-303.805		26.233								2286
				-286.000										2287
														2288
	4			-293.000				359.99	180.000				1.00	2289
				-298.500										2290
														2291
														2292
	4		64										5.00	2293
			75											2294
	4		65	-307.000									1.00	2295
														2296
	4		74										1.00	2297
														2298
														2299
	4			-394.765		25.099							1.00	2300
														2301

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
		80												2303
	4			-408.305		25.099							1.00	2304
		75		-409.305		26.000								2305
														2306
	4			-408.305		29.000								2307
														2308
								180.00						2309
													1.00	2310
140														2311
		74				25.000								2312
				-303.805										2313
				-286.000		26.242								2314
	4			-293.000				359.99	0.000				1.00	2315
		64												2316
		75											5.00	2317
	4			-307.000									1.00	2318
		65												2319
	4												1.00	2320
		74												2321
				-394.765		25.108							1.00	2322
	4													2323
		80		-408.305		25.108							1.00	2324
														2325
		75		-409.305		26.000								2326
	4			-408.305		29.000		180.00					1.00	2327
	4													2328
141														2337
		74				25.000								2338
				-303.805										2339
				-286.000		26.251								2340
	4			-293.000				359.99	180.000				1.00	2341
		64												2343
		75		-298.500									5.00	2345
	4													2346
		65		-307.000									1.00	2350

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********	2350
	4		74										1.00	2351
														2352
	4			-394.765		25.117							1.00	2353
		80												2354
	4			-408.305		25.117							1.00	2355
			75											2356
	4			-409.305		26.000							1.00	2357
				-408.305		29.000	180.00							2358
														2359
														2360
														2361
														2362
142			74	-303.805		25.000								2363
	4			-286.000		26.260								2364
														2365
	4		64	-293.000				359.99	0.000				1.00	2366
			65											2367
	4		75	-298.500										2368
														2369
														2370
													5.00	2371
	4		65	-307.000										2372
														2373
	4		74										1.00	2374
														2375
		80		-397.765		25.126							1.00	2376
	4													2377
			75	-408.305		25.126							1.00	2378
	4			-409.305		26.000								2379
				-408.305		29.000	180.00							2380
														2381
														2382
														2383
														2384
														2385
														2386
														2387
														2388
143			74	-303.805		25.000								2389
	4			-286.000		26.269								2390
														2391
	4			-293.000				359.99	180.000				1.00	2392
														2393
														2394
														2395
	4		64	-298.500									5.00	2396
														2397
														2398

N	G	M	S	X-AXIS	Y-AXIS	Z-AXIS	A-AXIS	C-AXIS	D-AXIS	I-OFFSET	J-OFFSET	K-OFFSET	FEEDRATE	
****	**	**	***	**********	*********	*********	**********	**********	**********	**********	**********	**********	**********	
			75	-307.000										2399
	4	65											1.00	2400
														2401
	4		74										1.00	2402
														2403
	4			-394.765		25.135							1.00	2404
														2405
	4	80		-408.305		25.135								2406
														2407
	4			-409.305		26.000							1.00	2408
														2409
	4		75	-408.305		29.000		180.00						2410
														2411
														2412
														2413
														2414
144			74	-303.805		25.000								2415
				-286.000		26.278								2416
														2417
	4			-293.000				359.99	0.000				1.00	2418
														2419
				-298.500										2420
	4	64												2421
														2422
	4		75	-307.000									5.00	2423
														2424
														2425
	4	65											1.00	2426
														2427
	4		74										1.00	2428
														2429
	4			-394.765		25.143							1.00	2430
														2431
	4	80		-408.305		25.143								2432
														2433
	4		75	-409.305		26.000							1.00	2434
								34.000		180.00					2435
														2436
														2437
			2	-100.000	0.000									2438
														2439
														2440
														2441
														2442
														2443

DISTRIBUTION LIST
US ARMY AVIATION SYSTEMS COMMAND
PRODUCTION ENGINEERING MEASURES PROJECTS
FINAL OR INTERIM REPORTS

No. of Copies	To
	Commander; US Army Aviation Systems Command; PO Box 209; St. Louis, Missouri 63166
10	ATTN: AMSAV-EXT
1	ATTN: AMSAV-FE (Cliff Sims, Maint Engr)
1	ATTN: AMSAV-EQ (C. Crawford, Sys Dev & Qual)
1	ATTN: AMSAV-FES (H. Bull, Corpus Christi)
2	ATTN: AMSAV-ZDR (Ref Library)
1	Project Manager; Advanced Attack Helicopter; ATTN: AMCPM-AAH, TM; P.O. Box 209; St. Louis, Missouri 63166
1	Project Manager; Utility Tactical Transport Aircraft System; ATTN: AMCPM-UA-T; P.O. Box 209; St. Louis, Missouri 63166
1	Project Manager; CH-47 Modernization; ATTN: AMCPM-CH47M; P.O. Box 209; St. Louis, Missouri 63166
1	Project Manager; Advanced Scout Helicopter; ATTN: AMSAV-SIA, P.O. Box 209; St. Louis, Missouri 63166
1	Product Manager; Aircraft Survivability Equipment; ATTN: AMCPM-ASE-TM; P.O. Box 209; St. Louis, Missouri 63166
1	Product Manager; Cobra; ATTN: AMCPM-CO-T; P.O. Box 209; St. Louis, Missouri 63166
1	Product Manager; Iranian Aircraft Program; ATTN: AMCPM-IAP-T; P.O. Box 209; St. Louis, Missouri 63166
4	Commander; US Army Materiel Command; ATTN: AMCRD-TE; 5001 Eisenhower Avenue; Alexandria, Virginia 22333
1	Director; Eustis Directorate; US Army Air Mobility R&D Lab; ATTN: SAVDL-EU-TAS; Ft. Eustis, Virginia 23604
1	Director; Ames Directorate; US Army Air Mobility R&D Lab; ATTN: SAVDL-AM; Ames Research Center; Moffett Field, California 94035
1	Director; Langley Directorate; US Army Air Mobility R&D Lab; ATTN: SAVDL-LA; Mail Stop 266; Hampton, Virginia 23365

No. of Copies	To
1	Director; Lewis Directorate; US Army Air Mobility R&D Lab; ATTN: SAVDL-LE: 21000 Brook Park Rd; Cleveland, Ohio 44135
1	Director; US Army Materials & Mechanics Research Center; Watertown, MA 02172 ATTN: AMXMR-PT
1	Director; Production Equipment Agency; Rock Island Arsenal; ATTN: AMXPE-MT; Rock Island, IL 61201
	Air Force Materials Laboratory; Manufacturing Technology Division; Wright-Patterson Air Force Base, Ohio 45433
1	ATTN: AFML/LTM
1	ATTN: AFML/LTN
1	ATTN: AFML/LTE
1	Commander; US Army Electronics Command; Ft. Monmouth, NJ ATTN: AMSEL-RD-P
1	Commander; US Army Missile Command; Redstone Arsenal, AL 35809 ATTN: AMSMI-IIE
1	Commander; US Army Troop Support Command; 4300 Goodfellow Blvd.; St. Louis, MO 63120 ATTN: AMSTS-PLC
1	Commander; US Army Armament Command; Rock Island, IL 61201 ATTN: AMSAR-PPR-1W
1	Commander; US Army Tank-Automotive Command; Warren, MI 48090 ATTN: AMSTA-RCM.1
12	Commander; Defense Documentation Center; Cameron Station; Building 5; 5010 Duke Street; Alexandria, Virginia 22314
2	Hughes Helicopter; Division of Summa Corporation; ATTN: Mr. R.E. Moore, Bldg. 314; M/S T-419; Centinella Ave & Teale Street; Culver City, CA 90230
2	Sikorsky Aircraft Division; United Aircraft Corporation; ATTN: Mr. Stan Silverstein; Section Supv, Manufacturing Tech.; Stratford, Connecticut 06497
2	Bell Helicopter Co.; ATTN: Mr. P. Baumgartner, Chief, Manufacturing Technology; P.O. Box 482; Ft. Worth, Texas 76101
2	Kaman Aerospace Corp.; ATTN: Mr. A.S. Falcone, Chief of Materials Engineering; Bloomfield, Connecticut 06002

No. of Copies	To
2	Boeing Vertol Company; ATTN: R. Pinckney, Manufacturing Technology; Box 16858; Philadelphia, PA 19142
2	Detroit Diesel Allison Division, General Motors Corporation; ATTN: James E. Knott; General Manager; P.O. Box 894; Indianapolis, Ind. 46206
2	General Electric Company; ATTN: Mr. H. Franzen; 10449 St. Charles Rock Road; St. Ann, MO 63074
2	AVCO-Lycoming Corp.; ATTN: Mr. V. Strautman, Manager Process Technology Laboratory; 550 South Main Street; Stratford, Conn. 08497
2	United Technologies Corp.; Pratt & Whitney Aircraft Div.; Manufacturing Research and Development; ATTN: Mr. Ray Traynor; East Hartford, Conn 06108